Power and The Engineer

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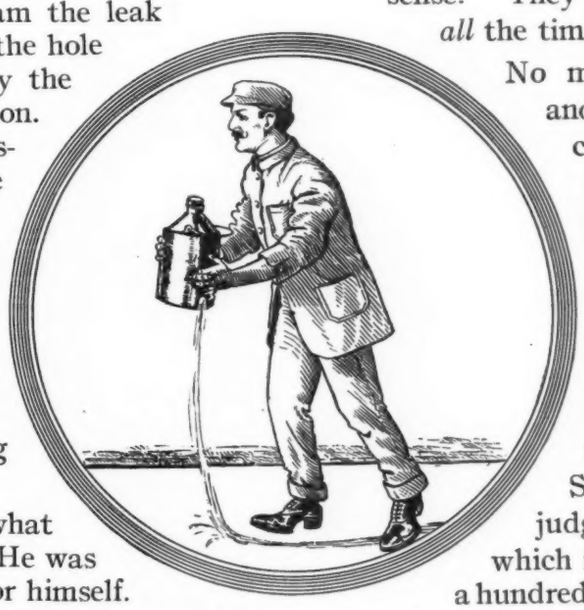
HERE is a true tale. The incident seems so far-fetched that there is considerable risk in using it. However, it is such a pat illustration of what we wish to bring out that the risk is worth while.

A certain artisan was discovered walking along the street carrying one of those cans that are often used for oil or other liquid.

In some way or another a hole had been staved in the side of the can near the bottom and our hero was having an awful and awkward time trying to dam the leak by holding one hand over the hole while he continued to carry the can in an upright position. He was only partly successful in his purpose, for he was leaving a trail of drops which leaked through his fingers. It never occurred to him that he could stop the loss by the simple expedient of carrying the can in a horizontal position with the hole facing upward.



That lad badly lacked what we call common sense. He was utterly unable to think for himself. He could not reason out that the can might advantageously be carried in any other than the normal position.

Common sense is a curious thing inasmuch as everyone, secretly at least, firmly believes that he possesses it in its true form and suspects that about everybody else lacks it, at some time or other at least. What one man may consider to be good hard common sense is often judged by others to be the limit of foolishness.

Perhaps one way in which proof of a man's exercise of common sense may be given is by "delivering the goods." Had the man who has just been mentioned "delivered the goods," that is, all of the goods in the can, he would probably have escaped being the goat in this talk.

Engineers—real engineers, not near engineers—more than the men of any other class, must possess and continually use common sense. They must "deliver the goods" *all* the time.

No matter how much schooling and training a man has received and how much experience he has had to guide him, unless he seasons it all with a few grains of common sense he is a dead loss.

Common sense is often inborn; it comes to some as naturally as breathing. Such people can give snap judgments and perform acts which in ninety-nine cases out of a hundred are exactly right, although they may have absolutely no precedents to guide them.

However, common sense may be acquired. In fact, it is by effort and study that most of us come to possess the modicum that we have.

If you practise thinking for yourself and reasoning things out—making *use* of your brain—it will not be long before the practice will become a *habit* and men will begin to discover that you have plenty of good hard common sense.

Large Southern Cotton Mill Plant

By Warren O. Rogers

Cross-compound direct-connected units generate current for two large cotton mills having a total of 150,000 spindles. Current is stepped up from 600 to 1500 volts and transmitted two miles by aluminum wires.

The cotton mill of the White Oak plant, Greensboro, N. C., is one of the largest in the Southern States; it gives employment to about three thousand persons and is rated as a 75,000-spindle mill, the spinning-mill building being 155 feet wide and 720 feet long.

Such a structure with its vast amount of machinery would alone require considerable steam and power. A second plant, known as the Proximity mill, of practically the same output, also obtains its power from this same plant, so that the installation at the White Oak mill ranks among the largest of its kind in the South. Both the White Oak and Proximity mills make blue indigo denims; the annual output is 150,000 yards per day, and the yearly cotton consumption is approximately 60,000 bales.

Engine Room

The engine and generator room is 68 feet wide and 263 feet long. It contains four Filer & Stowell high-duty cross-compound engines, each having 30 and 60 by 60-inch cylinders, and running at a speed of 75 revolutions per minute. Two of the engines are connected to General Electric alternating-current generators of 1500 kilowatts capacity; the other two engines are connected to 1250-kilowatt alternators. All machines generate at 60 cycles and 600 volts. The engines run at 150 pounds steam pressure, with a vacuum of from 26 to 26½ inches. The receiver pressure carried averages seven pounds. Fig. 1 shows a general view of the engine room which is roomy and well lighted.

On the switchboard side of the engine room are placed three exciter sets, two of which are induction motor driven, the third being steam driven. The larger motor, which has a capacity of 187 horsepower, is direct connected to a continuous-current generator of 1000 amperes capacity. The smaller motor-driven unit consists of a 75-horsepower induction motor connected to a generator of 400 amperes capacity. The steam-driven unit consists of a 50-kilowatt direct-current generator direct connected to a 12x18-inch vertical steam engine, running at a speed of 280 revolutions per minute. The exciter sets, including the engine, are of General Electric make.

Boiler Room

The boiler house is 51 feet wide by 263 feet long, and contains 26 Heine water-tube boilers set in three batteries. Two of the batteries contain eight boilers, each of 200 horsepower capacity; the third battery has ten 250-horsepower boilers, which makes a total of 5700 nominal boiler horsepower. The overload capacity is 8000 horsepower. The average pressure carried is 155 pounds per square inch, but the boilers are capable of carrying 200 pounds pressure.

Each battery of boilers is equipped with a Green fuel economizer placed over the boilers and next to the wall. Fig. 2 shows a view of the boiler room, the method of delivering the coal and the arrangement of the steam pipes connecting to the header. Fig. 3 is a plan view of the engine and boiler rooms, and Fig. 4 is a cross-sectional view showing the arrangement of the jet condensers, the arrangement of the economizers and the location of the ashpit tunnel.

Back of each battery of boilers are located three Hoppes horizontal open heaters, one of 2000 horsepower and two of 1500 horsepower capacity. Placed be-

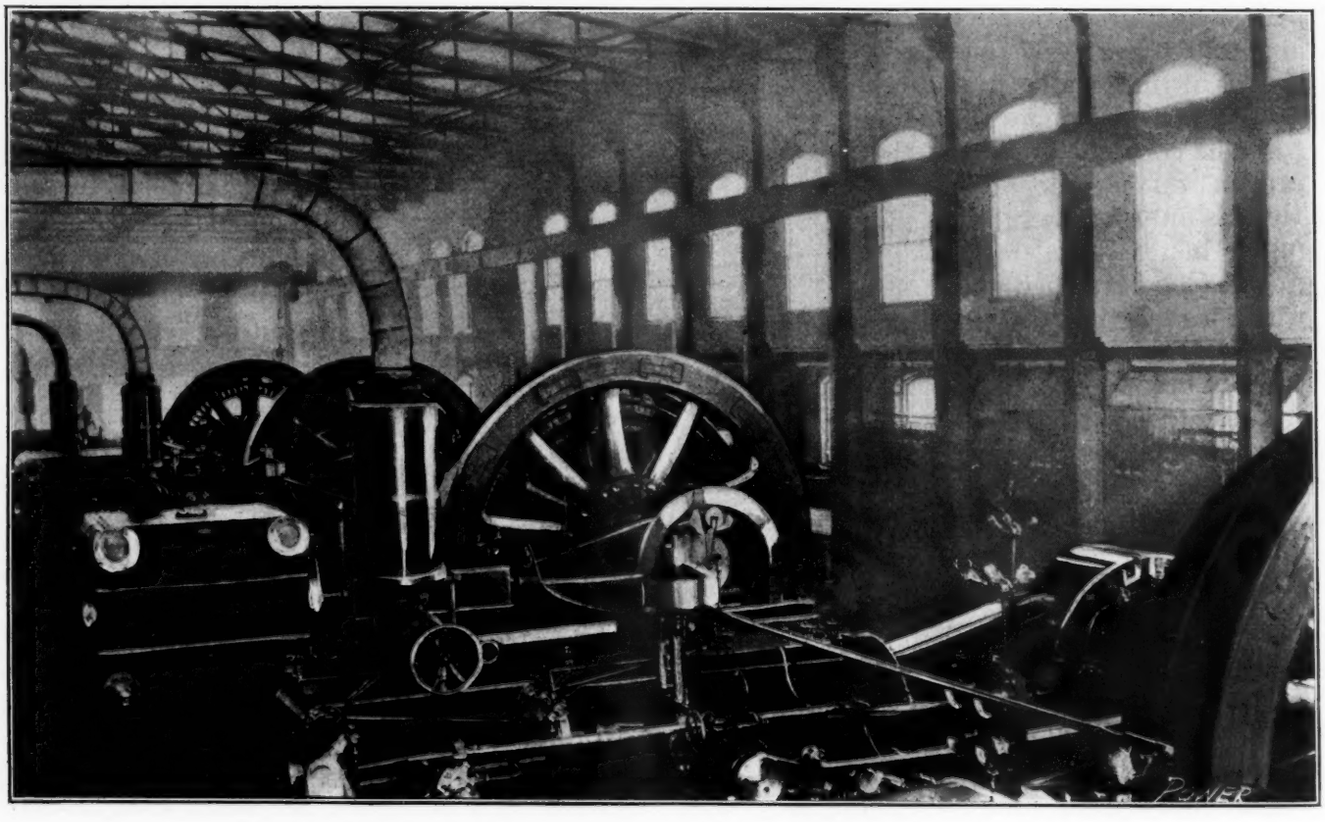


Fig. 1. View of Engine Room of the White Oak Cotton Mill Power Plant

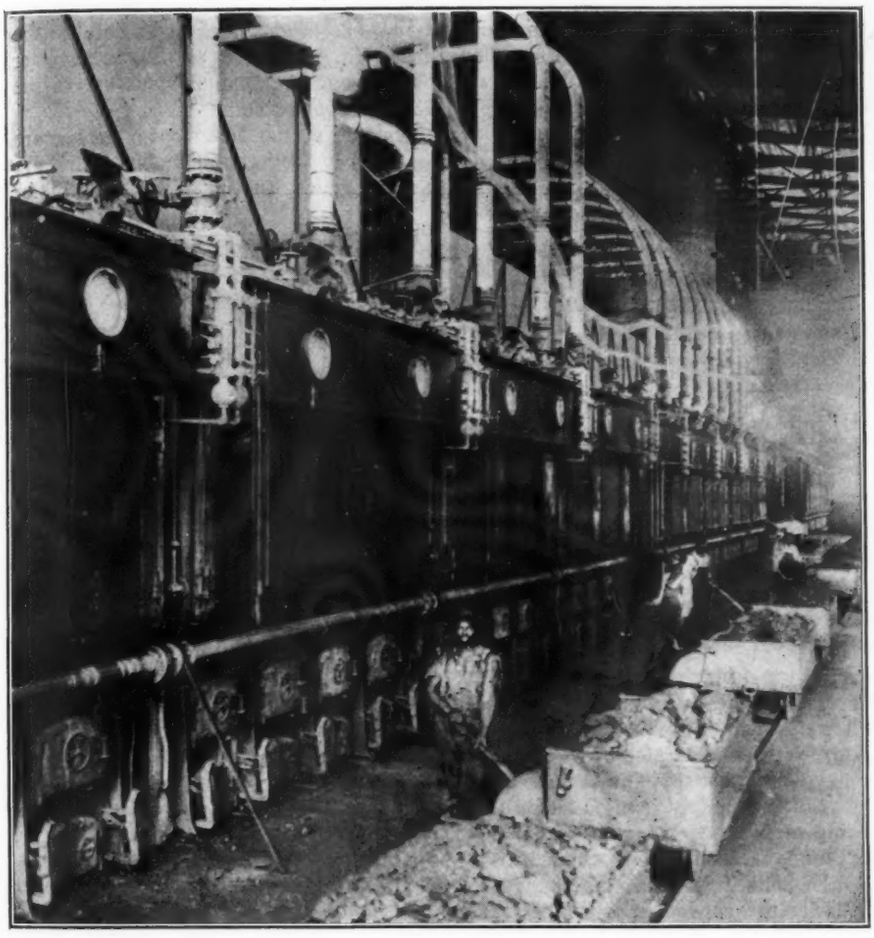


FIG. 2. VIEW OF THE BOILER ROOM OF THE WHITE OAK COTTON MILL POWER PLANTS

tween the setting of the first and second battery of boilers is a Deane 20 and 10 by 18-inch horizontal simplex outside-pump driven by a 75-horsepower General Electric induction motor partially shown in Fig. 5. These pumps all discharge into the

the boilers dictate. The feed water to the boilers can be bypassed around the heaters when necessary.

The boilers of batteries Nos. 1 and 2 of the 200-horsepower units are connected to a 20-inch header; the 250-horsepower boilers are connected to a 16-inch header by long 5-inch bends, as shown in Fig. 2. From the steam headers to each engine, 10-inch pipe connections having long-radius bends are installed. A Sweet direct separator is placed above the throttle on each engine connection. The exhaust pipe from each of the engines to the condenser is 22 inches in diameter.

HANDLING ASHES AND COAL

The method of handling the ashes is out of the ordinary. The ashpit floors are sloped from the back of the grates toward the front of the boiler setting, and cleaning-out doors are set in the brickwork forming the boiler front. Under the floor of the boiler room and extending its entire length, is an ash tunnel in which an ash car runs on a narrow-gage track. The ashes from the grates fall into the ashpit proper, and when it is desired to remove them from the ashpit a 2-inch pipe, to which is attached a hose, is placed in the ashes; after opening the cleaning-out doors, water is turned on and the ashes washed out either into the car or into the ash tunnel. In the latter case it is necessary to shovel the ashes into the ash-conveyer car, while in the former instance no handling is necessary. When the ash car has been filled, it is drawn to one end of the ash tunnel, and up an elevated track to a position over a concrete ash bin located at one end

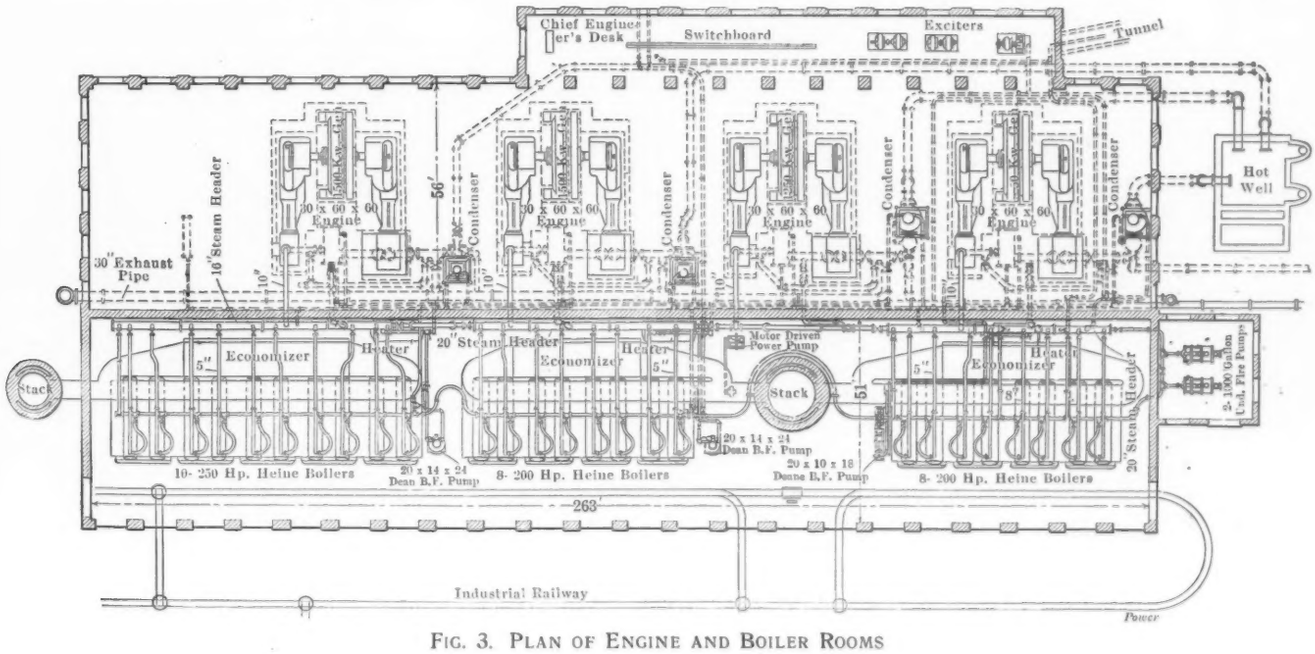


FIG. 3. PLAN OF ENGINE AND BOILER ROOMS

packed boiler-feed pump; there are also two 20 and 14 by 24-inch Dean vertical boiler-feed pumps, Atlantic type, and one 9x12-inch triple-plunger Deane power

same feed pipe. The electrically driven pump is operated at full speed all the time and the vertical pumps are regulated fast or slow as the water level in

of the boiler house on the outside. In this bin the ashes are dumped, and when it is full a wagon is used to cart the ashes away.

The coal used in the plant is brought in hopper cars and delivered to an elevated bin from which it is loaded into small

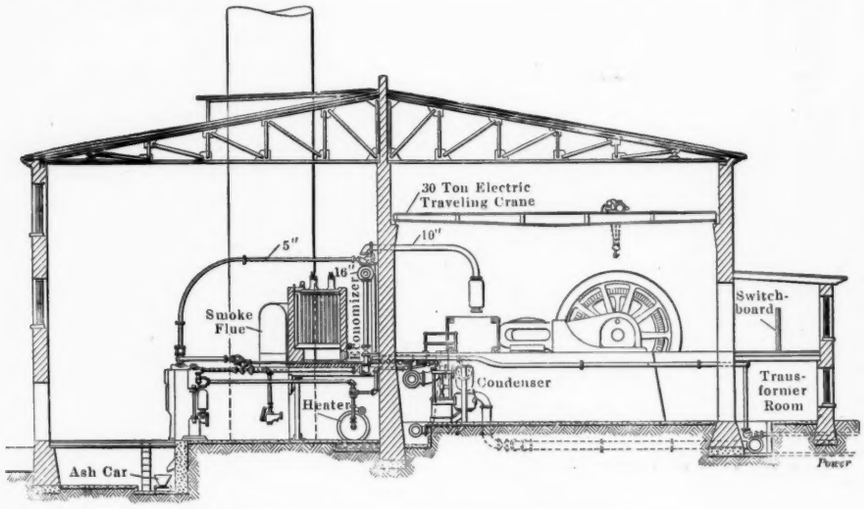


FIG. 4. ELEVATION OF BOILER AND ENGINE ROOM

firing cars, and is delivered to the front of the boilers.

Fig. 6 shows the location of the jet condensers, of which there are four, two being of the Deane vertical type, size 20 and 20 by 24 inches, and two of the Dean Brothers vertical type, size 20 and 38 by 18 inches. All are placed below the floor level in the basement.

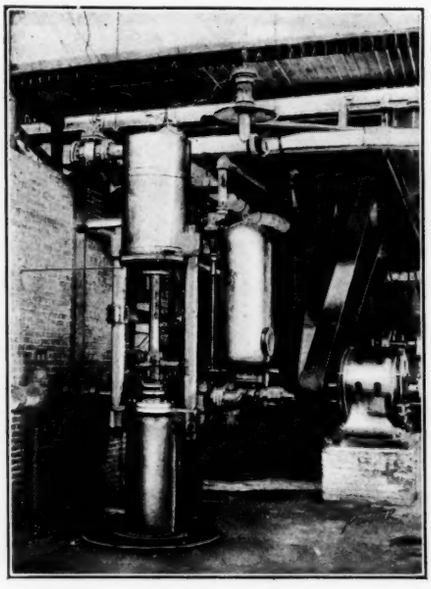


FIG. 5. STEAM AND MOTOR-DRIVEN PUMPS

The engines are all equipped with a gravity-oiling system. The oil returns from the engine bearings to Burt unit oil filters located in the basement, which are arranged as shown in Fig. 7. After being filtered the oil is pumped to an overhead tank.

PIPING

The main steam engines are piped to a single main header, while the auxiliaries receive steam from a separate header on which a pressure of 50 pounds is maintained. The auxiliaries may be supplied with steam from the main header if necessary. A nonreturn valve is used at each connection between the boilers and header. The exhaust pipe of each engine is so arranged that the high- or low-pressure cylinders can be operated either condensing or noncondensing. The exhaust pipe from each engine is connected to one atmospheric exhaust pipe, and the auxiliaries are connected to a single exhaust pipe so that the exhaust steam can be passed through the heater or to the atmosphere, as may be desired.

Extra-heavy fittings are used on all high-pressure steam lines, and all pipes 5 inches and over are fitted with van stone joints. The boiler-feed pipes, fittings and valves are all of brass. The main atmospheric exhaust pipe, double galvanized and spiral riveted, is provided with extra-heavy fittings.

There are two 175-foot brick stacks, one 9 feet and the other 12 feet in diameter. The larger stack takes care of the gases from the sixteen 200-horsepower boilers, and the smaller stack serves the 250-horsepower boilers.

Outside of the boiler room proper are located two 1000-gallon Underwriters' fire pumps which supply the fire-sprinkler system with water. Water for all the departments of the mill is taken from a nearby creek which flows at a rate of about 4000 gallons per minute to a reservoir having a capacity of approximately 10,000,000 gallons.

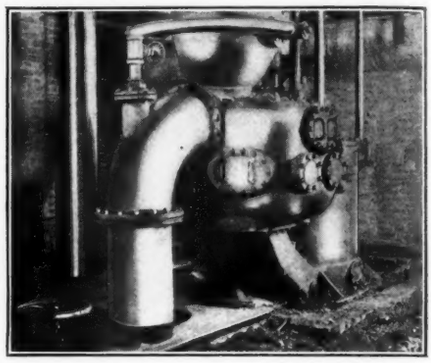


FIG. 6. JET CONDENSER SET IN THE BASEMENT

Outside of the power plant proper is a substation which transforms the current and distributes it to the Proximity mill, a distance of two miles, at 1500 volts. The steel towers, carrying high voltage aluminum wires, are spaced at a distance of 600 feet, requiring in round numbers about 20 towers.

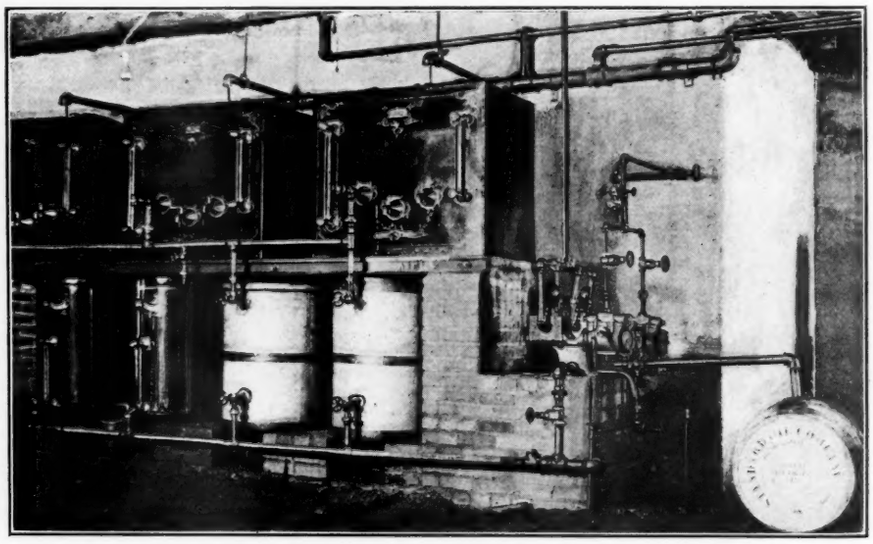


FIG. 7. ARRANGEMENT OF OIL FILTERS IN THE BASEMENT

The purchase of coal on the basis of its heat content is of the same utility as a definite understanding regarding the quality of any other commodity of commerce or industry.

Roller Bearings in the Line Shaft

By John A. Schroeder *

It is claimed that roller bearings in the line shaft will cut the friction of babbitted bearings in half, thus reducing the total power bill by from 10 to 20 per cent, and this saving increases with the increase of load.

Special requirements of line shaft bearings.

One of the main causes of waste of power in a manufacturing plant lies in the transmission of power through line shafting, caused by the friction in the bearings. In all other departments vast improvements have been made, tending to effect savings and thus reduce the manufacturing cost. The means for transmitting power through the plant, however, where line shafting is used, are virtually the same today that they have been for years; shafting is still running in babbitted bearings and the only improvements in this line have consisted in introducing various devices for oiling the bearings.

A few years ago there was a tendency to abolish line shafting entirely, running all machines by individual motors. It has been found, however, that unless the machines thus driven are run only intermittently or each machine requires quite an amount of power, the low efficiency of small motors, together with the high cost of the great number of them, with wiring, starting devices, etc., render this system uneconomical. It is generally conceded that the most economical transmission of power is by what is termed "grouped drives." A number of machines are run from one motor, through one or more line shafts.

There is always a great deal of friction where shafting is run in babbitted bearings, even where the shaft is perfectly alined. In most manufacturing plants, through the settling of buildings, the loosening of set screws, and the springing of the shafts, this friction load is increased greatly, and the time has come when the manufacturer is asking himself if there is no way or means by which he can reduce his friction load.

In machinery of all kinds ball and roller bearings have been introduced and their extensive use clearly demonstrates the saving they effect. Of the two, the ball bearing, presenting only point contact, is the most efficient and should be used wherever possible. Under heavy and varying loads, however, and in places where bearings must be split, the roller bearing is more successful.

When the question arises as to how to reduce the friction load in a manufacturing plant, attention naturally is turned to ball and roller bearings, and manufacturers of transmission machinery have lately given this matter a great deal of attention. Ball bearings of several makes, designed for line-shaft purposes, have been on the market for some time. It is, however, impracticable to split a ball race, and a line-shaft bearing should necessarily be split, in order to be practicable. The attention therefore turns to roller bearings, and some roller bearings successfully used on special machinery and in special places have been applied to line shafts. In some cases they have given satisfaction; in many others not, from the fact that in applying these roller bearings to this service the necessity of changing the construction was not taken into consideration. Recently roller bearings, constructed especially for line-shafting service, in the construction of which care has been taken to meet all requirements to be encountered in such service, have been placed upon the market, and will fill a long felt need and demand.

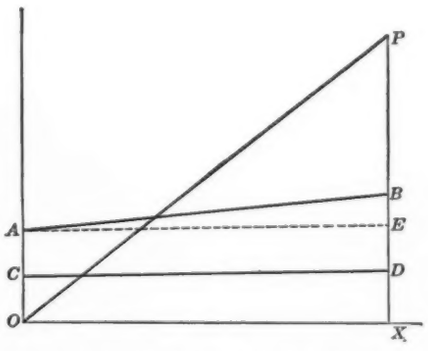


DIAGRAM OF TOTAL POWER REQUIRED AND INCREASE OF FRICTION WITH LOAD

The conditions and requirements peculiar to line shafting service are as follows:

Soft steel in the shafts.

More or less end play.

More or less springing in the shaft.

A commercial cold-rolled, cold-drawn or turned shaft is made from a low-carbon, therefore soft steel, and if hard rollers are run directly on this, it will soon show wear. A high-carbon steel bushing should, therefore, be provided, securely clamped to the shaft, so as to present a hard wearing surface for the rollers to revolve upon and to provide an absolute protection to the shaft.

In most roller bearings the rollers or roller structures have been revolved between stationary ends of the bearing boxes. If applied to a line shaft, the end play existing will force the rollers or roller structures against the stationary ends, causing friction and wear. In a roller bearing intended for line-shaft service, the roller structures should, therefore, be of the floating type, absolutely free and clear, and no revolving part should be allowed to run against any stationary part.

The belt on either side of line-shaft bearings will often cause the shaft to spring more or less, this springing causing the shaft to bend in the center of the bearing. If the rollers are run loose in the box, this bending of the shaft may cause them to get out of alinement, to bend and to bind. A properly constructed roller bearing for line-shaft service should, therefore, have the roller alined so as to be kept at all times parallel with one another and with the shaft. In a roller bearing for any class of service, the shorter the rollers are the more efficient is the bearing. The question then arises, how long should the rollers be in order to make the bearing most efficient, consistent with required strength. If a roller is alined so that it is at all times kept parallel with the shaft, it cannot be subjected to anything but an absolute crushing strain. It should, therefore, be of sufficient diameter and sufficient length to withstand a crushing strain equal to, or somewhat above the shearing strain of the shaft. If such is the construction, a roller cannot break unless there should be a flaw in the steel from which it is made.

Consideration must be given to the wear of the bearing. The bearing should be so constructed that the wear be allowed to come on such parts that can be most cheaply and readily replaced. If the rollers are made of a high-grade, high-carbon steel and they are case hardened and ground, they will show very little, or no wear, running against surfaces of softer material. It is a well known fact that steel running against cast iron gives as efficient results in regard to nonwear, as any two metals. If the box itself is made of a good grade of cast iron, there will be very little wear on the box itself. The bushing which protects the shaft is necessarily thin, and could not be made of cast iron. It should, therefore be made of a high-carbon steel, but not case hardened, so that the wear will come on this bushing and none on the rollers. The bushing, naturally, can be cheaply and easily replaced.

The friction load in a manufacturing plant is the power required to run the shafting with all machinery standing idle, in other words, with clutches thrown out, when such are used, or with belts running over loose pulleys, where tight and loose pulleys are used. It is very seldom that the friction load is less than 30 per cent. of the power load. Very often it runs 40 per cent. and above. With properly con-

*Mechanical engineer Royersford Foundry and Machine Company, Philadelphia, Penn.

structed roller bearings, properly installed, this friction load can be cut practically in half, which means a saving of from 10 per cent. to 20 per cent. of the total power used.

As load is thrown on the shafts, the friction in the babbitted bearings is increased, due to the increased pressure between shaft and bearing. The friction at full load, that is with all machines running, is, therefore, greater than at no load; viz., where babbitted bearings are used. Where shafts are equipped with roller bearings, however, there is but a very slight increase in friction, if any at all, with increased load, so that the total saving of power by the use of roller bearings in place of babbitted bearings is even greater than the saving in friction load alone. The accompanying diagram will clearly illustrate this.

Line *OP* represents the power required for driving the machinery; with no load at *O*, and full load at *P*. The friction load is represented by line *A B*, with shafting equipped with babbitted bearings, and by line *C D* when equipped with roller bearings. At no load, the power required to drive shafting, the friction load, with babbitted bearings is *A O;* with roller bearings *C O*. As load is thrown on, the friction in the babbitted boxes increase until at full load it is *B X; P B* being the power actually used for driving the machinery. With roller bearings the friction increases very slightly, if at all, with increased load, so that the friction at full load, *D X*, is about the same as *C O* at no load. The saving in so called "friction load" is *A C;* the saving in power at full load is *B D*. Drawing *A E* parallel with *C D, B E* is the additional saving in power at full load. The total power required to drive machinery and shafting, with babbitted bearings is *P X;* with roller bearings *P X* less *B D*.

In every manufacturing plant, records should be kept of the power used as well as of the friction load. At regular intervals indicator diagrams should be taken from the engine, or readings of the motors, with friction load only, as well as with full load. If either is found excessive, it should be reduced and kept reduced. The line shafting should be kept properly alined and whenever possible, roller bearings should be used. No better investment can be made than substituting roller bearings for the babbitted bearings, if thereby a saving can be effected of from 10 per cent. to 20 per cent. of the total power used, the net result of lessening the friction load by one-half. A saving of 10 per cent. in the total power will, as a rule, pay for the cost of substitution in a year's time or less.

It must be remembered that roller bearings should not be used indiscriminately. When line shafting is run at unusually high speeds, or when the load is in the nature of shocks, such as in a forge shop, where drop hammers are used, they are unsuitable. The continual shocks, reverting back to the rollers, will gradually crystalize these until they finally break.

Explosion of Cast Iron Steam Pipe*

An 18-inch cast-iron pipe, carrying 100 pounds steam pressure, exploded as a result of a crack which had been started by tightening too much on the flange bolts. The packing was wholly within the bolt circle.

A section of 18-inch cast-iron steam piping about 5 feet in length recently exploded at the steel works of John Spencer & Sons, Newcastle-on-Tyne. The pipe had a flange 1⅜ inches thick at one end, stiffened by eight ribs, and the other end, which was plain, fitted into the stuffing box of an expansion joint. The thickness of the metal varied from ¾ to 1 $\frac{1}{16}$ inches and the section was located near the engine, as shown in Fig. 1.

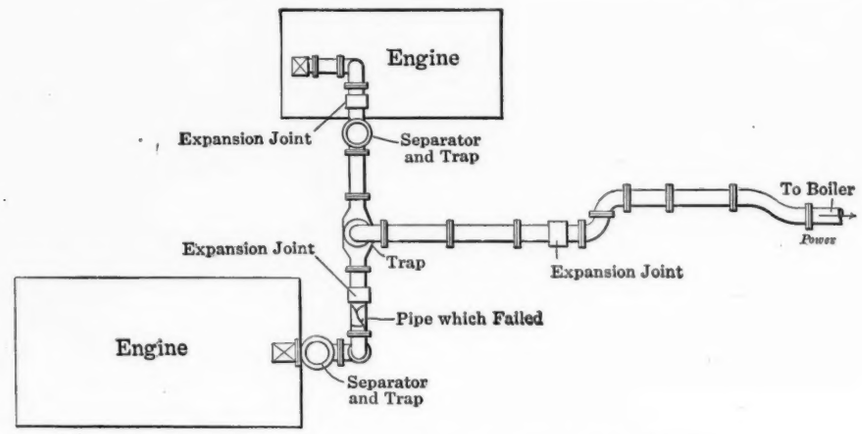


FIG. 1. SHOWING LOCATION OF PIPE WHICH FAILED

The safety valve of the boiler was set to blow off at 100 pounds pressure, but the pipe had been designed for a pressure of 120 pounds and withstood a hydraulic test of 200 pounds.

The flange joints were of a type commonly found in cast-iron piping, a rubber ring about 1½ inches wide by ¼ inch thick being fitted inside the bolt circle. Three days before the explosion the joint was repacked; the attendant took out four of the bolts, slackened up on the other four, scraped the joint and inserted a new rubber ring. When replacing one of the bolts he noticed a crack in the flange, extending from the edge through the hole to the fillet and about 2 inches along the pipe. A 5x9-inch plate was fitted over the crack and held in place by one of the flange bolts and a band extending around the pipe. The flange bolts were then tightly screwed up by means of a spanner lengthened by a piece of tube till it had a leverage of nearly 4 feet.

When steam was turned on the crack leaked considerably, but it was thought that the temporary repair would hold until a new section could be procured. Three days later, however, an explosion occurred, entirely wrecking the pipe but injuring no one. The fractured section is shown in Fig. 2.

It is believed that the crack was caused by tightening too much on one of the flange bolts. Where jointing material is placed wholly inside the bolt circle, undue stresses are set up in the metal when the bolts are screwed up, and failures have often been due to this cause. It is preferable that the jointing material extend across the face of the flange.

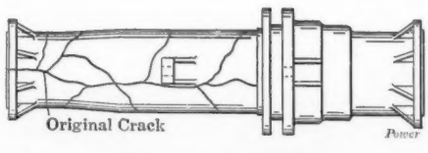


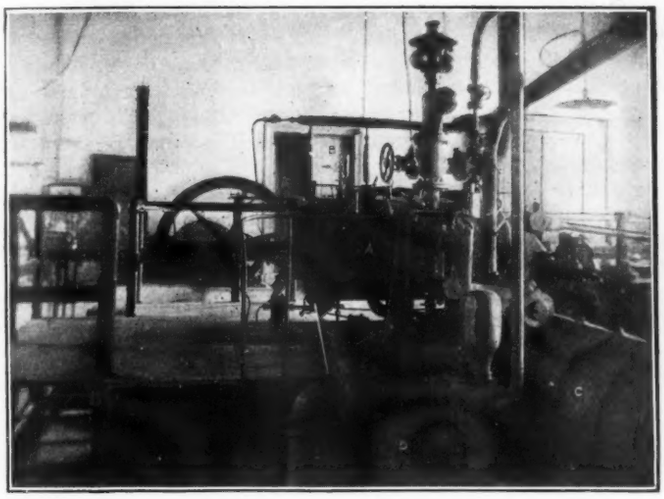
FIG. 2. FRACTURED PIPE

*From report of British Board of Trade.

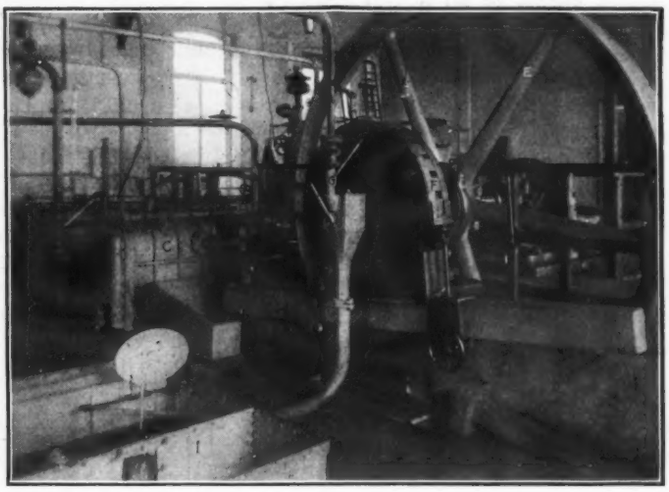
In case of low water, cover the fire with wet ashes, or with green fuel if wet ashes are not available, and close the fire and ashpit doors. Do not touch the safety valve. Do not turn on the feed water under any circumstances. Let the steam outlets remain as they are until the boiler has been cooled off and examine to determine what damage has been done.

Laboratory of Dwelshauvers-Dery

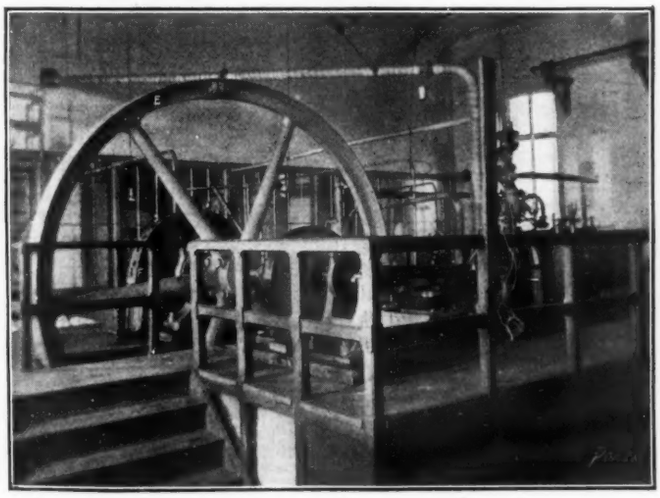
Since the article descriptive of our visit to the laboratory of the University at Liège appeared upon page 1617 of the issue of September 6, we have received from Professor Dwelshauvers-Dery the accompanying views of the interior of that laboratory, showing the engine and apparatus upon and with which were made the famous tests which showed that compression was not a cure for clearance, which tests were reviewed in our issue of June 28, with a complete description of the engine and apparatus here illustrated. The conclusions reached by Professor Dery were questioned by Professor Heck in our issue of September 13, to which Professor Dery replies in our issue of September 27. We should be glad to see the subject call out still more discussion and to see some of our laboratories take the matter up for still further experimental determination. In the meantime these photographs of the steam machinery and apparatus of the tests under discussion will be interesting, the engine in particular and what little can be seen of the original Richards' indicator.



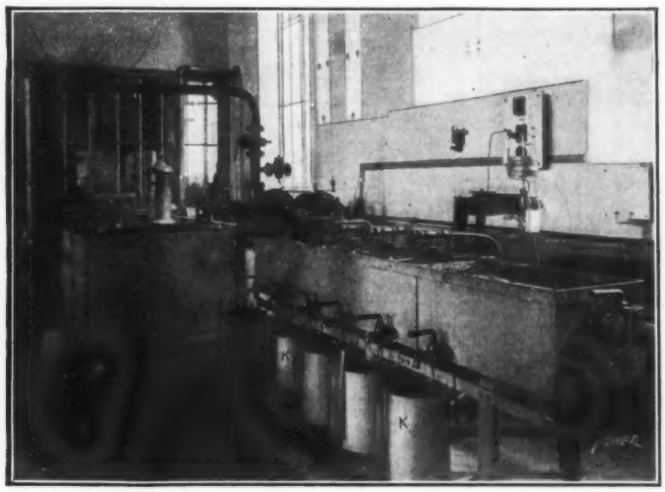
A, cylinder of the famous Beer engine. The guides of this engine carry a scale divided into thousandths part of the stroke (0.0234 inch), with a vernier, making it possible to locate the position of the piston to 0.002 of an inch. The riding cutoff valves have separate scales and verniers, all reading to 0.004 inch.
B, Richards indicator purchased at the exposition of 1862.
C, surface condenser.
D, air pump with thermometer at outlet.



F, brake pulley.
G, thermometer at inlet of water to brake.
H, thermometer at outlet.
I, gaging tank fitted with weir for measuring water supplied to brake pulley. The water level is measured with a scale which has to be read with a lens. The addition of four or five drops in a tank of 500 gallons may be at once detected.



Crank side of engine with brake *F* in background and flywheel *E* to the fore.



K, measuring tanks for gaging water of condensation from jackets, valve chest and pipes.

EXPERIMENTAL STEAM ENGINE AND EQUIPMENT IN THE ENGINEERING LABORATORY AT LIÈGE

The concrete pipe line just completed for the Ontario Power Company is declared to be unique in its engineering features among the great pipe lines of the Continent. It is, in fact, the only one of its kind and size in the world. In diameter it is 18 feet, and a mile and a quarter in length. Costing over $1,000,000, it took but five months to complete it. Resting on a solid foundation of concrete, it traverses a section of almost every known variety of soil. Rock, gravel, loam and quicksand were encountered. The number of bags of cement used was 247,642, besides 2350 tons of steel. Its walls are fully 18 inches in thickness. The big pipe could easily be used as an underground-railway tube.

Standardization of the Boiler Room

By William A. Russell

A concrete example involving tests and investigations into the boiler-room conditions of a plant. A method is cited of making standardization tests of the performance of a boiler whereby coal can be bought on a B.t.u. basis to suit any market prices.

Many good articles and books have been written upon boiler-room economy; CO_2 has been discussed at great length, bitter war has been waged on the question of embodying a heat-unit basis in coal specifications, and much trade literature exists on the operation of stokers and mechanical-draft appliances; still there exists, to an almost unbelievable extent, the "happy-go-lucky" method of selecting the kind and grade of fuel to be used.

When the man responsible for the use of a certain fuel is asked why he uses a particular kind and grade, in the majority of cases he will give no other reason than the routine and the profound conviction that no other kind would be as economical as the one in use. In a few cases the excuse will be given that the men are accustomed to this kind and would not know how to use another, or that the fuel was changed some years ago and therefore must be the most economical. Usually the purchasing agent for the plant uses all his shrewdness and experience in trying to force down the price of fuel, while at the same time the "conviction" of the engineer and the absence of a little curiosity and experimenting on his part, may cost the owner much more than the shrewdest buying can save.

The process by which the seemingly complicated problem of selecting the most economical fuel can be solved so as to take into account the fluctuations in coal prices, is very simple and is easily accomplished in everyday practice. Of course, this method does not go into academic refinements, but by substituting experience and knowledge for pure guesswork, it tends to guide correctly the man who is desirous of saving his money. The writer believes that the method herein presented will be best explained by citing a concrete case where he was called upon recently to act in a consulting capacity.

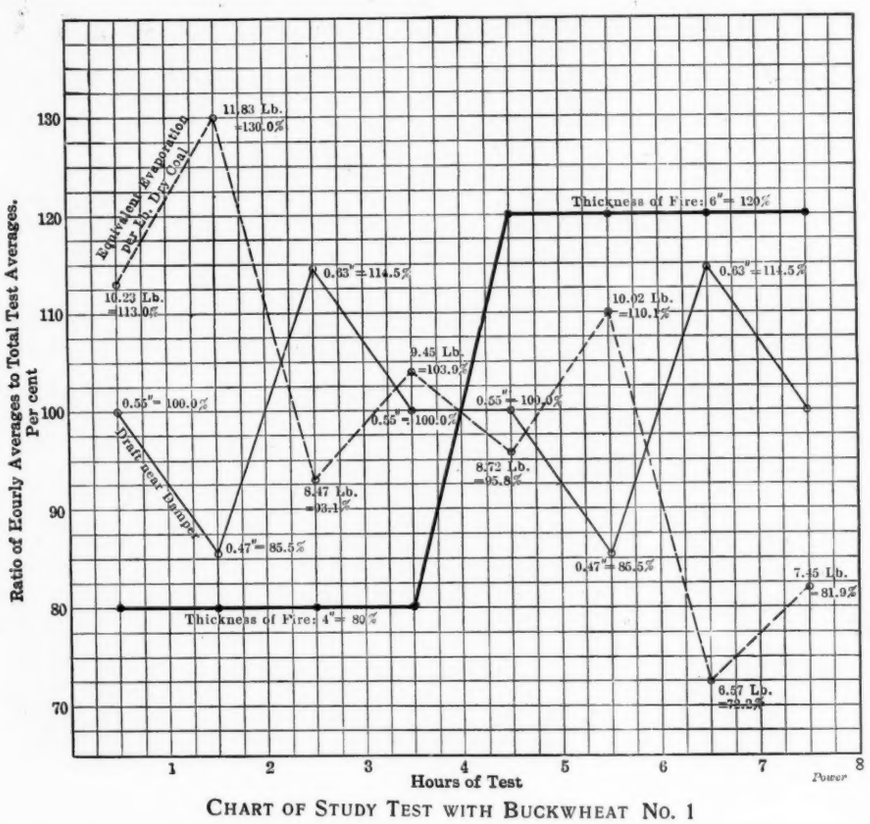


CHART OF STUDY TEST WITH BUCKWHEAT NO. 1

The plant was a large water-pumping station, the boiler rooms of which contained twenty boilers having a total rated capacity of about 4000 horsepower. These boilers were distributed in two boiler rooms, each room having a separate stack. Boiler room *A* had twelve horizontal fire-tube boilers with inside furnaces, each with a rated capacity of 200 horsepower; and boiler room *B* had eight horizontal tubular boilers of the same rated capacity. In boiler room *A* it was found necessary to run not more than nine boilers at a time; two of them were usually out of service for repairs and at least one had to be kept in reserve for emergency purposes; hence, the ordinarily required capacity of this boiler room was 1600 horsepower. In boiler room *B* it was found possible to run six boilers at once, keeping two idle for repairs and reserve; hence, the capacity ordinarily required for boiler room *B* was 1000 horsepower.

The plant was hand fired when the investigation was begun and broken-sized anthracite coal was used. The particular conditions of the plant made the prevention of smoke a fundamental condition. Preliminary investigations of the fuel problem made it clear that the following combinations could be considered:

For hand firing,

- Broken coal having an average of 13,070 B.t.u. as delivered.
- Pea coal having an average of 11,930 B.t.u. as delivered.
- Buckwheat No. 1 having an average of 11,840 B.t.u. as delivered.
- Buckwheat No. 3 having an average of 11,750 B.t.u. as delivered.
- A mixture of 4/5 buckwheat No. 3 and 1/5 bituminous slack having a total average of 12,060 B.t.u. as delivered.

For mechanical stoking,

- Semi-bituminous "run-of-mine" having an average of 14,500 B.t.u. as delivered.
- Bituminous slack having an average of 13,300 B.t.u. as delivered.

Owing to the labor conditions, the firemen, although getting $3 per 8 hours' shift, could not be made to handle more than two boilers with the larger sizes of coal and one and one-half with smaller sizes, especially with the contemplated mixture. The cost of delivering coal to the boiler room and that of removing the ashes from it, had been taken into consideration as there were a number of so called "laborers" around the plant who did this work. With mechanical stokers installed it was found to be possible for one fireman to handle as many as eight boilers with the occasional assistance of these laborers.

The first step was to determine through a series of evaporative tests the maximum efficiency and the resulting capacity with each of these fuels. A careful inquiry among different manufacturers of mechanical stokers elucidated the fact that they would guarantee an efficiency in boiler room *A* of 72 per cent. (boiler and grate) and in boiler room *B* an efficiency of 65 per cent. for semi-bituminous "run-of-mine" with a capacity of 133 per cent. of the rating in both cases. In view of the stipulation that the combustion must be as smokeless as possible, these companies did not undertake to guarantee an efficiency of more than 65 per cent. in boiler room *A* and 60 per cent. in boiler room *B* with 100 and 110

per cent. respective capacities with bituminous slack. The depreciation of the mechanical stokers for boiler room *A*, including chutes, etc., reduced to a rate per 10,000 pounds equivalent evaporation and including a comparatively large estimated yearly cost for repairs, was placed at somewhat less than 2 cents. The cost of each fireman in boiler room *A*, receiving $3 wages per 8 hours' shift and reduced to a rate per 1000 pounds equivalent evaporation, amounted to 7 cents. For boiler room *B* these figures were 3 cents and 1.1 cents respectively.

A series of tests were run with the five grades of fuel previously mentioned under "hand firing." The tests were run in conformity with the standard code of the American Society of Mechanical Engineers, two for each fuel and each of eight hours' duration. These tests were all made on the same boiler and within three weeks, the weather conditions being constant during that time, and the soot being blown out after every second test. The first test for each fuel was in the nature of a study test.

Of the many variable conditions influencing the efficiency and capacity of a boiler, two can be easily regulated by the men firing the boilers: namely, the draft which can be controlled through regulation by individual hand dampers with the help of fixed draft gages, and the average thickness of the fuel bed. Therefore, with the general conditions during the whole period of these tests approximately constant, the writer decided to concentrate his entire attention on these two factors, and to study them in a systematic way.

Each study test was subdivided for this purpose into halves of four hours each, and during each of these periods the thickness of the fire was kept constant and the draft, near the damper, was subjected to exactly the same variations in each half of the test. The fires were cleaned one hour before the start and one hour before the end of each test. Careful observations were made of the water and coal, firing being allowed only at fixed intervals and the weight of each charge being recorded.

Table 1 represents the data of a satisfactory study test, with buckwheat No. 1, and from this the accompanying chart has been compiled in a somewhat novel but rather convenient way. On the middle ordinate of each hourly period are marked off the average thickness of the fire, the average draft near the damper and the average equivalent evaporation per pound of dry coal. All of these are expressed in per cent. of the corresponding averages for the whole test:

TABLE 1. STUDY TEST.

Periods.	Thickness of Fires.	Draft near Damper.	Equivalent Evaporation per Pound of Dry Coal.
First hour...	4 inches = 80 per cent.	0.55 inch = 100.0 per cent.	10.28 pounds = 113.0 per cent.
Second hour.	4 inches = 80 per cent.	0.47 inch = 85.5 per cent.	11.83 pounds = 130.0 per cent.
Third hour..	4 inches = 80 per cent.	0.63 inch = 114.5 per cent.	8.47 pounds = 93.1 per cent.
Fourth hour.	4 inches = 80 per cent.	0.55 inch = 100.0 per cent.	9.45 pounds = 103.9 per cent.
Fifth hour...	6 inches = 120 per cent.	0.55 inch = 100.0 per cent.	8.72 pounds = 95.8 per cent.
Sixth hour..	6 inches = 120 per cent.	0.47 inch = 85.5 per cent.	10.02 pounds = 110.1 per cent.
Seventh hour	6 inches = 120 per cent.	0.63 inch = 114.5 per cent.	6.57 pounds = 72.2 per cent.
Eighth hour.	6 inches = 120 per cent.	0.55 inch = 100.0 per cent.	7.45 pounds = 81.9 per cent.
Averages....	5 inches = 100 per cent.	0.55 inch = 100.0 per cent.	9.10 pounds = 100.0 per cent.

TABLE 2.

No. of Test.	Kind of Coal.	Efficiency, Per Cent.	Capacity, Per Cent.
1	Broken.....	72	105
2	Pea.....	75	100
3	Buckwheat No. 1..	80	90
4	Buckwheat No. 3..	72	75
5	Mixture, buckwheat No. 3 and slack.	65	85

TABLE 3.

No. of Test.	Kind of Coal.	Efficiency, Per Cent.	Capacity, Per Cent.
1	Broken.....	70	110
2	Pea.....	72	100
3	Buckwheat No. 1..	75	85
4	Buckwheat No. 3..	68	70
5	Mixture, buckwheat No. 3 and slack.	70	85
6	Semi-bituminous "run of mine"..	65	135
7	Bituminous slack..	60	110

The second test for each fuel was run with a draft near the damper and a thickness of the fire as close as possible to the ones which jointly had shown the best evaporation during the corresponding study test. For instance, during the second test with buckwheat No. 1 the draft was kept as close as possible to 0.47 inch and the thickness of the fire was kept between 3½ and 4½ inches. The result showed very high, giving an efficiency of the boiler and grate of 80.1 per cent., which corresponsd to an evaporation of 10.36 pounds from and at 212 degrees per pound of combustible.

The results of the five final tests are given in table 2.

The guarantees of the stoker companies, as heretofore mentioned, were efficiencies of 72 and 65 per cent. at capacities of 133 and 100 per cent. with semi-bituminous "run-of-mine" and bituminous slack respectively.

A similar series of tests in boiler room *B* gave the following data, including the guarantees of the stoker companies:

Tables 2 and 3 contain the standards for the boiler rooms *A* and *B*.

Of course, it might have been advisable to try one more fuel in both boiler rooms, namely, a mixture of ¼ bituminous slack and ¾ buckwheat No. 3, but this was refrained from because the firemen were not always able to prevent the formation of smoke of greater density than was permissible.

After having determined the standards as explained, the rest of the economical calculations is simple. It remains only to ascertain the prices for the different kinds and grades of coal, and from these and the average heat values and efficiencies, to calculate the cost of an equivalent evaporation of 1000 pounds; then by adding the labor costs, depreciation and maintenance charges on special apparatus, the problem is solved.

TABLE 4. BOILER ROOM A.

Kind of Coal.	Price per Gross Ton.	B.t.u. per Pound as Delivered.	Price per Thousand B.t.u. as Delivered.	Capacity in Boiler Horsepower per Boiler.	Number of Boilers Needed.	Number of Firemen Needed.
Broken.....	$4.95	13,070	0.1691	210	8	4
Pea.....	4.05	11,930	0.1515	200	8	4
Buckwheat No. 1.....	3.10	11,840	0.1169	180	9	6
Buckwheat No. 3.....	2.05	11,750	0.0779	150	11	7
Mixture, ¾ buckwheat No. 3 and ¼ slack.....	2.24	12,060	0.0829	170	10	7
Semi-bituminous, "run of mine".....	3.25	14,500	0.1001	266	6	1
Bituminous slack.....	3.00	13,300	0.1007	200	8	1

TABLE 5. BOILER ROOM B.

Kind of Coal.	Price per Gross Ton.	B.t.u. per Pound as Delivered.	Price per Thousand B.t.u. as Delivered.	Capacity in Boiler Horsepower per Boiler.	Number of Boilers Needed.	Number of Firemen Needed.
Broken.....	$4.95	13,070	0.1691	220	5	3
Pea.....	4.05	11,930	0.1515	200	5	3
Buckwheat No. 1.....	3.10	11,840	0.1169	170	6	4
Buckwheat No. 3.....	2.05	11,750	0.0779	140	7	4
Mixture, ¾ buckwheat No. 3 and ¼ slack.....	2.24	12,060	0.0829	170	6	4
Semi-bituminous, "run of mine".....	3.25	14,500	0.1001	266	4	1
Bituminous slack.....	3.00	13,300	0.1007	220	5	1

In this particular case, the following quotations were received per gross ton:

Broken	$4.95
Pea	4.05
Buckwheat No. 1	3.10
Buckwheat No. 3	2.05
Semi-bituminous "run-of-mine"	3.30
Bituminous slack	3.00

In calculating the cost of evaporating 1000 pounds of water the capacity standard must be taken into consideration; this will enable a determination of the cost of the firemen and the depreciation and maintenance charges for the mechanical stoker. The unit costs of these items have been already quoted in the first part of this article. Tables 4 and 5 are self-explanatory:

TABLE 6. PRIMARY COST OF 1000 POUNDS EQUIVALENT EVAPORATION IN BOILER ROOM A.

Kind of Coal.	Cost of Fuel, Cents.	Cost of Labor, Cents.	Depreciation of Mechanical Stokers, Cents.	Total Cost, Cents.
Broken	22.7	2.8	...	25.5
Pea	19.5	2.8	...	22.3
Buckwheat No. 1	14.1	4.2	...	18.3
Buckwheat No. 3	10.4	4.9	...	15.3
Mixture, ⅘ buckwheat No. 3 and ⅕ slack	12.3	4.9	...	17.2
Semi-bituminous, "run of mine"	13.4	0.7	0.2	14.3
Bituminous slack	15.0	0.7	0.2	15.9

TABLE 7. PRIMARY COST OF 1000 POUNDS EQUIVALENT EVAPORATION IN BOILER ROOM B.

Kind of Coal.	Cost of Fuel, Cents.	Cost of Labor, Cents.	Depreciation of Mechanical Stokers, Cents.	Total Cost, Cents.
Broken	23.3	3.3	...	26.6
Pea	20.3	3.3	...	23.6
Buckwheat No. 1	15.1	4.4	...	19.5
Buckwheat No. 3	11.1	4.4	...	15.5
Mixture, ⅘ buckwheat No. 3 and ⅕ slack	11.4	4.4	...	15.8
Semi-bituminous, "run of mine"	14.9	1.1	0.3	16.3
Bituminous slack	16.2	1.1	0.3	17.6

Tables 6 and 7 were calculated from the preceding efficiencies and cost data:

Under the particular market conditions stated in the foregoing, the semi-bituminous, "run-of-mine" coal proved to be the most economical for boiler room *A*. For boiler room *B*, the most economical fuel would have been buckwheat No. 3, but as this would have necessitated the running of seven boilers, which is more than the original conditions allowed, the somewhat less economical mixture of ⅘ buckwheat No. 3 and ⅕ bituminous slack was selected.

On the basis of this calculation, founded on the prevailing market prices at the given time, the writer advised the firm to contract for coal containing the following number of heat units:

Boiler room *A*,

$$\frac{1600 \times 24 \times 365 \times 34.5 \times 965.7^{*}}{0.72} = 648{,}564$$

million B.t.u.

of semi-bituminous "run-of-mine" coal at the guaranteed price of $0.1001 per million B.t.u. No penalties were advised, except that only analyzing below 13,500 B.t.u. per pound as delivered and above 12 per cent. ash in dry coal be rejected.

Boiler room *B*,

$$\frac{1000 \times 24 \times 365 \times 34.5 \times 965.7}{0.70} \times \frac{0.2 \times 13{,}300}{12{,}060}$$

$= 91{,}961$ million B.t.u.

of bituminous slack at the guaranteed price of $0.1007 per million B.t.u. and,

$$\frac{1000 \times 24 \times 365 \times 34.5 \times 965.7}{0.70} \times \frac{0.8 \times 11{,}750}{12{,}060}$$

$= 324{,}973$ million B.t.u.

of buckwheat No. 3 at the guaranteed price of $0.0779 per million B.t.u.

No penalties were to be imposed in this case either, only that coal analyzing worse than the following limits was to be rejected:

Bituminous slack, 12,800 B.t.u. as delivered and 15 per cent. ash.

Buckwheat No. 3, 11,000 B.t.u. as delivered and 18 per cent. ash.

Now, suppose that at the end of the year certain changes in the conditions of boiler room *A* permitted the use of eleven out of the twelve available boilers, and further, that the price of only the semi-bituminous "run-of-mine" had changed, having gone up to $3.75 per gross ton, which would be equivalent to a price of $0.1155 per million B.t.u.

Under these conditions next to the last line in table 6, as well as in table 7, would have to be changed so as to read respectively

$$15.5 + 0.7 + 0.2 = 16.4$$

and

$$17.2 + 1.1 + 0.3 = 18.6.$$

No further boiler tests are necessary; knowing the boiler standards, which are settled once for all as long as the equipment remains the same, the engineer in charge of the plant will presumably decide to change to buckwheat No. 3 straight, in boiler room *A*, thus saving $5320 as compared with the cost of continuing to use semi-bituminous "run-of-mine." Even allowing $1200 for a change of grates in all the boilers, this would leave a saving of $4000 for the year. Boiler room *B* would, of course, continue to use the same mixture as before.

The method of standardizing a boiler room as described in the foregoing concrete instance may seem somewhat cumbersome, but in actual practice it will very seldom, if ever, be necessary to standardize for so many different grades and sizes of coal. Two or three will usually cover the entire range of possibilities, in which case only from four to six evaporative tests will be necessary. In the case described, the owners stubbornly insisted upon the larger sizes of anthracite, and to demonstrate clearly to them the wastefulness of these grades, it was necessary to run the complete series of tests. The important feature of this method is that the selection of the fuel to be used can be made scientifically, and independently of anybody's fancy or biased opinion.

*At the time this test was conducted the recently accepted value of 970.4 for the latent heat of vaporization at 212 degrees Fahrenheit, was not in general use.

Sid Diggles' ingin busted its guvner belt an' run away. Sid busted his suspenders an' all uv the sprintin' records doin' likewise.

Th' difference 'tween a Missourian an' an alternator is thet one has t' be cited, an' th' other excited 'fore they'll do bizness, b' gosh.

"Reddy" Gallagher sez thet he has th' best uv th' rest uv us when it cums ter goin' inter a biler. Says he leaves his hat off an' don't need any torch.

Th' inspecter called on old Hal Mossback, at th' ladies' rat factory, an' diskivered thet Hal hed bin runnin' fer 17 years on a barber's license thet he'd got when he graddyated frum th' barber college down in Punkville, Indianny.

Old Bill Grimes' firm put in a new biler-feed pump. Bill jined church th' next Sunday. Sed he'd wanted t' jine fer th' last 40 years but cudn't be a Christian an' handle th' dumd old feed pump et th' same time. There's a lot uv us in th' same fix.

Hi Jimson, th' ingineer at th' bustle factory, went up fer license tother day. Th' inspecter ast him what he'd do ef his ingin started t' run away. Hi used t' be a cowboy an' he sed that he'd lasso th' dumd critter an' put th' hobbles on it.

Th' inspecter writ him up a fust-class license, limited t' 23 hosspower.

Pete Blowoff kim over t' borrer sum cylinder ile uv me tother day. Sed he'd set th' cylinder-ile jug too clost t' th' one he used hisself an' hed drunk it all up 'fore he noticed th' difference. Sed thet he prob'ly wudn't hev noticed th' mistake only thet he'd filled th' lubricater out'n his own jug, an' th' ingin got ter cuttin' up sumthin' scandulus.

Sum people think the're ingineers when they get so they kin hit th' hole in th' furnis wunst er twist in a while with a scoopful uv coal, an' know enuf t' keep th' steam frum all leakin' out by hangin' a grate bar on th' safety-valve lever.

These kind uv ingineers air thicker'n fleas on a fat pup in sum parts uv th' kentry.

The Fallacy of the Hydrodynamo

Once more the application of a system of floats has been brought into use for the ostensible purpose of creating power out of nothing. The device is described and its fallacy pointed out.

The principles of hydraulics have again undergone distorted interpretations to suit a device called the hydrodynamo which is being promoted by the Indiana Power Company, of Indianapolis. The term *perpetual motion,* which has long been accepted as an inventive nightmare, has been carefully avoided in reference to this device, although the claims are equally, if not more, fallacious than those of the former class. Here great power is supposed to be attained without the expenditure of any energy or of any energy-producing agent, and from the tone of the *prospectus* it would appear that hydraulic engineers have heretofore been groping in the dark as to the great possibilities of hydraulics.

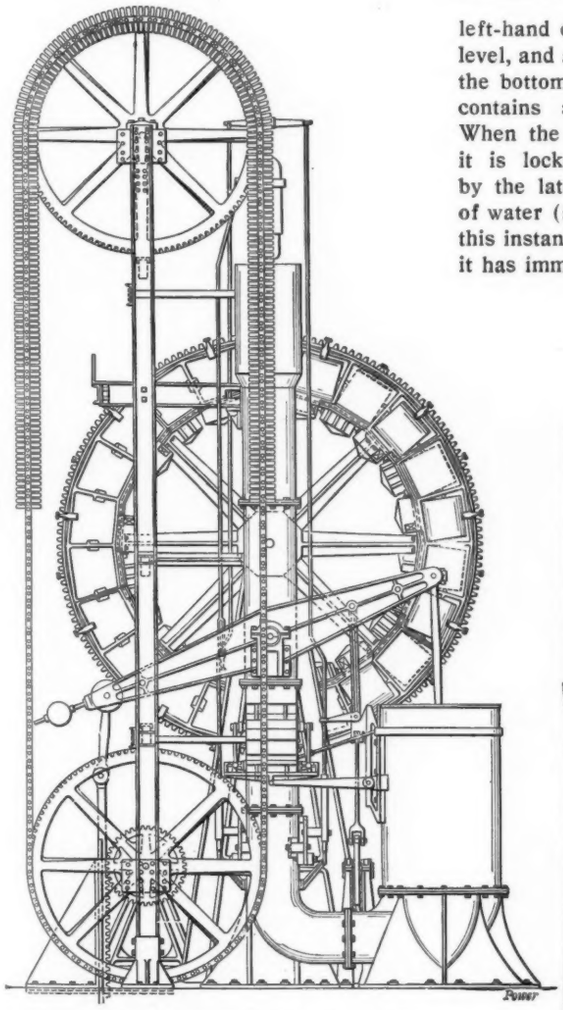


FIG. 1. THE HYDRODYNAMO, SIDE VIEW

To quote from the prospectus regarding a description of the device, "The principal elements of construction are a hydrostatic balance, a series of floats adapted to be raised in the balance, a driving chain operated by these floats, and a number of links connecting these parts together."

The front view, Fig. 2, represents the left-hand column of water at the receded level, and a float *F,* falling by gravity from the bottom drum into the cylinder which contains air at atmospheric pressure. When the float has entered the cylinder it is locked securely in the pocket *P* by the latch *L*. The right-hand column of water (see the front view, Fig. 2), is at this instant at its highest level. In rising it has immersed a float which was locked in position until the column reached its highest level, at which instant the float was released and, being much lighter than the water which it displaces, it rises and compresses the spring buffer at the top of the column, dropping out of the top by gravity into the waiting compartment of the driving drum. In entering the driving drum, the float trips the latch which holds the drum and the latter moves forward.

In the act of turning forward (the drum being clutched to the hydrostatic balance beam) the hydrostatic balance of the left-hand column, Fig. 1, causes the water to rise to the highest level, while the right-hand column of water is falling, the cylinders being connected by a crossbeam. When the water in the left-hand column is at its maximum hight the float is released, rising to the top and rolling into the compartment at the top of the drum. While the float in the left-hand column is rising, a float has been brought into the floatway at the lower part of the right-hand cylinder and drops by gravity to its locked position; in this way the machine continues to operate. Eleven floats are always in the front side of the drum and no floats whatever are in the rear side; this, according to the promoters, *develops a great mechanical torque producing power available for useful work.*

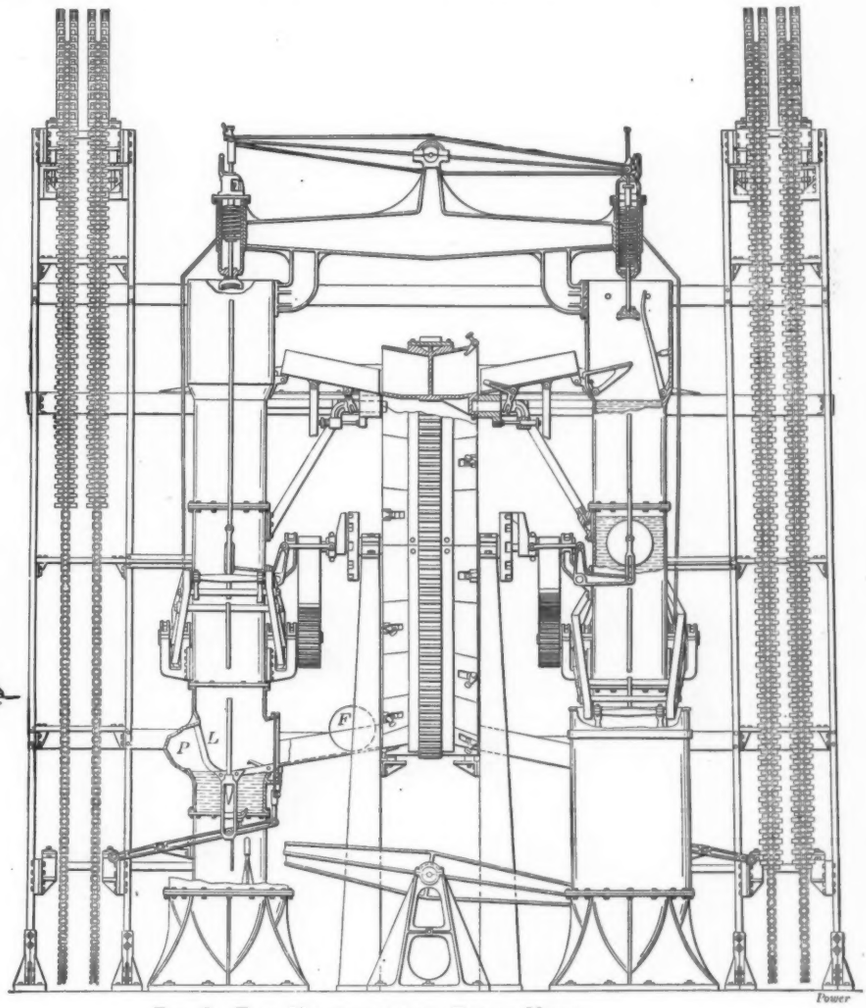


FIG. 2. THE HYDREDYNAMO, FRONT VIEW

The mechanical construction of the device, which seems somewhat complicated, is of small importance except that there is apparently considerable friction loss. It is the hydraulic operation wherein lies the "nigger in the woodpile."

The supposed power is derived by the weight of the floats acting through a distance equal to the diameter of the drum. At first glance it might appear that no energy is expended in raising these floats and that the energy derived through their fall is pure gain, but a closer study of the problem will show that when the float *F*, Fig. 2, has rolled into the pocket *P* and is held in position by the latch *L*, while the water rises, the volume of water displaced by the float, which is many times heavier than the latter, must be raised a greater distance than if the float were not immersed. This additional distance is equal to the difference in the levels of the water before and after the float has been released, and it requires power to lift this water. It may be said that this power is furnished by the weight of the eleven floats in the drum. True, but the force of these eleven floats acting through one-eleventh of the total fall is equivalent to one float falling the entire distance, or the eleven floats falling the entire distance would have to raise the column of water eleven times. Again, the fall of one column of water will not raise the other column the entire distance and the extra work of raising the water the total distance is at the expense of the force produced by the floats in the drum. The question naturally arises, "What power is left to accomplish external work?" When friction is taken into consideration the balance of power will undoubtedly be found to be a negative quantity. It would seem almost a physical impossibility for the machine to run light, much less than with a load.

There has not yet been any of these machines constructed, all the claims being based upon hypothetical assumptions and drawings, with the promoters content to offer stock for sale under the most alluring pretensions. It is said, however, that one is now being built; but until such time as a practical demonstration is made and the claims substantiated, we shall continue to maintain our present attitude regarding its impracticability.

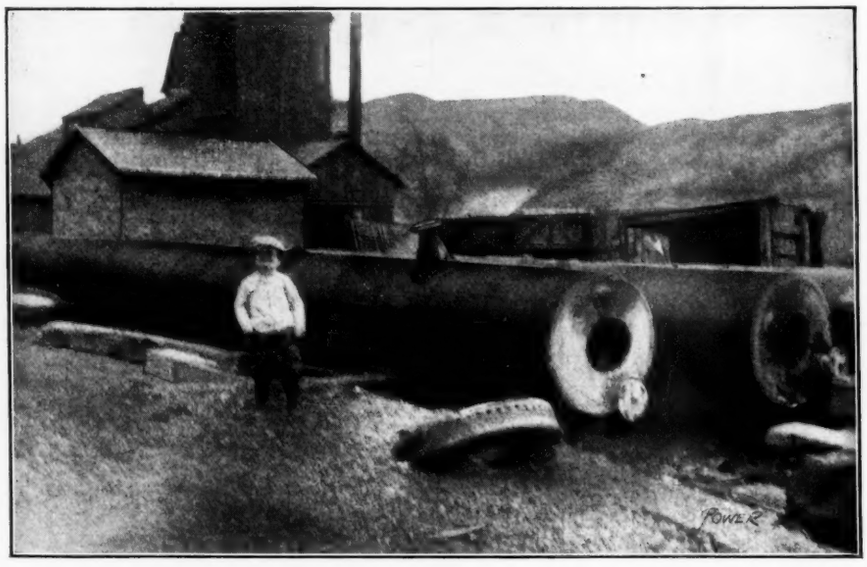
Forty Foot Cylindrical Boilers

By F. Webster Brady

This antiquated type of boiler, made up of many single-riveted sections with cast-iron heads, is still in use at a number of collieries in Pennsylvania, where its simplicity and adaptability to hard usage make its retention particularly desirable.

In the anthracite region of Pennsylvania there are still to be found many of the old type of cylindrical boilers, consisting of a long cylindrical wrought-iron shell with cast-iron heads. Some of these have been in service for many years, but are still fulfilling their purpose.

The illustration shows some of these old boilers, which were removed from a nearby colliery. They are 34 inches inside diameter and about 40 feet long, with the shells made up of eighteen sections of ¼-inch plate, single riveted at both the longitudinal and girth seams. The heads are of cast iron, having a 6-inch flange around the edge which fits into the shell, and are held in place by a single row of ¾-inch rivets. The front heads each have a manhole of regular size, and two flanged openings cast solid with it; the bottom, or feed opening, is 2¼ inches in diameter and the top, or steam connection, is 3 inches in diameter. The safety valve, which was of the ball-and-lever type, was mounted on the casting riveted to the top of the third section, as shown. A front head, separate from the shell, may be seen in the foreground of the illustration, also an extra rear head on the ground at the far end of the shell. The rear head is a solid casting without any openings. It is flanged and fitted to the shell in a manner similar to the front head. A wedge-shaped lug cast on the back head serves to attach a supporting sling, and two other supporting slings are spaced along the shell. There is a 6-inch handhole on top of the fourth section from the rear end.



40-FOOT CYLINDRICAL BOILERS WITH CAST-IRON HEADS

Boilers of this type are placed in banks of from two to twelve with a plain brick setting. The space between the shells is choked with bricks which usually become covered with a thick layer of flue dust. There is a continuous grate extending the whole width of the fire room and a single header connects all the steam flanges. The steam pressure usually varies from 50 to 100 pounds, according to the age and condition of the plant.

This type of boiler found favor among the collieries of this section because of its low cost, extreme simplicity and easy operation. Refuse, dirt and unsalable coal are burned under these boilers, and the boiler-room work is performed by the lowest grade of labor. The steam blower, usually consisting of a plain ⅜-inch pipe is in constant use. The ashpit, excepting a small space around the blower nozzle, and the dust chambers become filled with ashes, and it is not uncommon for the flame to burst from the firing doors or most any place around the shell. The metal stacks are about the same diameter as the boilers.

In a plant of this kind the equipment has to withstand much hard usage and abuse. Many of the happenings would end with serious results were it not that the equipment is so simple. These old boilers make good water tanks, stacks, etc., long after their steaming days are over.

Ottawa has a peat bog at her doors, estimated to contain over 5,000,000 tons of fuel, and three others within about 40 miles aggregating over 20,000,000 tons of peat.

Safety Stops for Steam Engines

By W. H. Wakeman

A safety stop on a steam engine is of as much importance as a safety valve on a steam boiler. In this article most of the safety devices used in connection with the engine governor are illustrated and their action described.

A safety stop for a steam engine is any kind of a device that will stop an engine should the governing apparatus get out of order, and, although some types of stop device will shut down an engine when the load is greater than it can carry under existing conditions, they should also be classed with the safety stop.

Fig. 1 shows a simple type of safety stop. An idler travels on the top side of the belt, and, should the belt break or slip off, the idler will fall into a lower

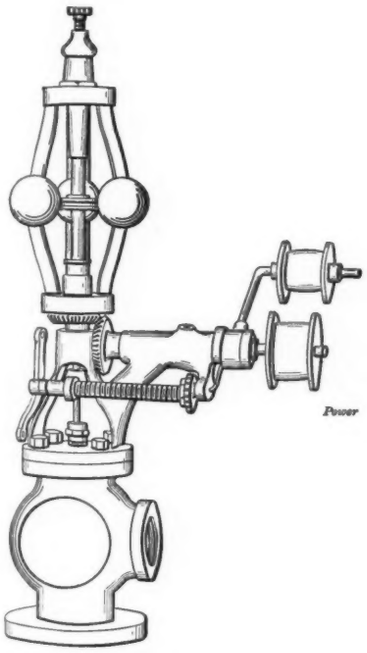


FIG. 1.

position. This disengages the speed pawl, releasing the valve, which drops, shutting off steam from the engine cylinder. The packing in the stuffing box around the valve stem should be kept in good order, as it is possible to prevent prompt action of this stop should the stuffing-box nut be screwed down too hard on unsuitable packing, or on packing that has outlived its usefulness.

The governor shown in Fig. 2 is located on the engine frame about 4 feet from the cylinder, instead of directly over the steam chest. Should the governor belt break, or be thrown from the pulley, steam would be shut off from the cylinder. The device for opening the steam valves is similar to the Corliss gear. Steam is admitted and cut off automatically from zero to about one-half stroke, under normal conditions, and if more load is added the flyballs take a lower position and steam follows the piston the entire stroke, providing the balls and center weight do not fall to their lowest possible position.

If the governor belt should break, or from any other cause the flyballs should move slower than usual, or stop, the center weight will drop as low as possible, which will cause the tripping toes on the cutoff mechanism to prevent the steam valves from opening, hence steam is not admitted to the cylinder, and the engine will stop. When it is time to shut down, a block is inserted, as shown at *A*. While this allows the center weight to go low enough to give steam to the cylinder during full stroke of the piston, it does not allow the safety stop to operate. This makes it possible to handle the engine properly, and not allow it to stop on either center. When starting the engine, and the throttle valve is wide open, the block *A* is removed from the governor.

Another device for blocking a governor is shown in Fig. 3, which, to a certain extent, is automatic in operation. It is shown in running position. The sliding block *B* is held in an out position by a concealed spiral spring. Should the governor belt fail, the flyballs will stop and the center weight will fall to its lowest position. If it is desired to shut the engine down in regular service, close the throttle valve and as the speed slackens, the stop lever *B* is pushed inward against the spiral spring until it strikes the spindle, and held there until the weight and collar *C* rests upon it. When the engine is started and the flyballs gain sufficient speed to raise the center weight, *B* is liberated, the spring throws it outward and the stop is set automatically.

A homemade device for blocking a governor on a Corliss engine is shown in Fig. 4. The sliding sleeve *A* is in a position for an average load on the engine, but if the throttle valve is closed the projecting pin *B* falls until it rests on the thick washer *C*, carried by the stationary pin *D*. This allows steam to follow the piston full stroke, and enables the engineer to stop the engine in any desired position. When the engine is started again and brought up to regular speed, *B* rises from the washer *C* which is then removed from the pin *D*. This permits the collar *B* to drop low enough to prevent the steam valves from hooking on the catch blocks should the governor belt break.

An automatic device for releasing a governor after it has been blocked is shown in Fig. 5. As soon as the flyballs revolve fast enough to raise the center weight, the catch piece *A* turns one-half revolution to the right on the pin *B*. This automatically sets the safety stop ready for an emergency, because *A* will not stay in the position shown unless it is held there.

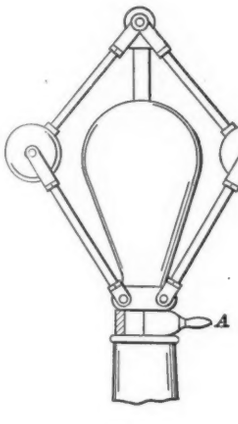


FIG. 2

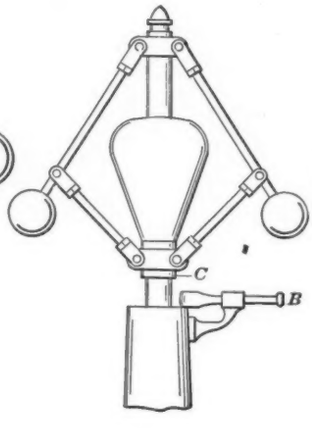


FIG. 3

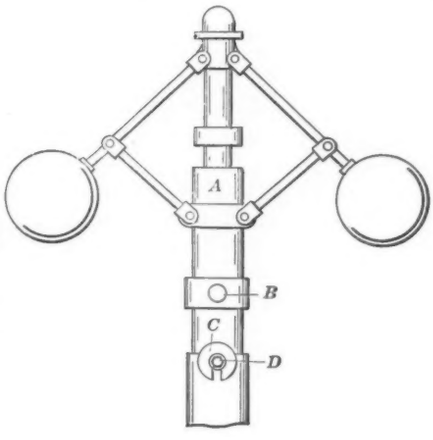


FIG. 4

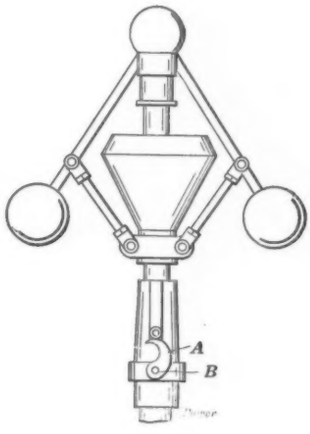


FIG. 5

Fig. 6 shows a safety stop in running position. When the governor is to be blocked while shutting down and starting again, the pin *P* is inserted in the hole *H* and prevents the flyballs from falling to their lowest position.

In case the engine should stop with the pin out of the hole *H*, first close the throttle valve, then lift up the flyballs and put the pin in the hole *H*. Then unhook the reach rod and rock the wristplate to its extreme travel in both directions so that

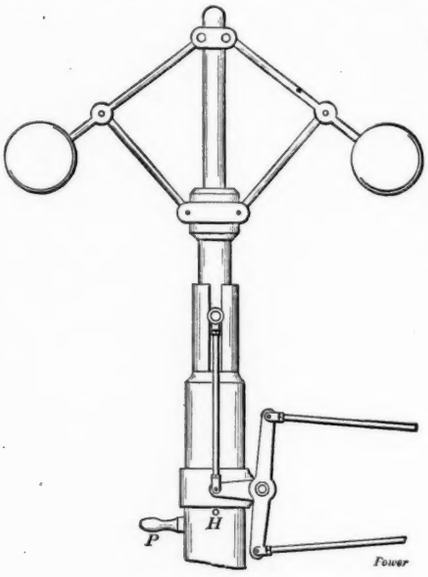


FIG. 6

both steam valves will catch into the catch blocks, and drop the reach-rod hook into place. Steam can then be turned on and the engine started.

The governor shown in Fig. 7 is in its running position with a heavy load on the engine. If more load is added the projecting pin *A* will rest on the movable collar *B* causing steam to follow the piston full stroke. If the collar *B* were moved until the vertical slot *C* is directly under pin *A*, and more load is put on the engine, the centerweight will fall to its lowest position, causing steam to be shut off from the cylinder.

A governor fitted with a centerweight appears to be much more sensitive than if the centerweight were omitted, hence it ought to operate a stop motion almost instantly. This form of governor is more sensitive while in full operation than the style shown in Fig. 6, but the former is always operated at a much higher speed, and it will run longer after the belt is removed. The effect of this action on the flyballs is partially offset by the centerweight. In either case great care should be taken to have the dashpot, which usually forms a part of such governors, properly adjusted, as otherwise it may hold the flyballs up for a few seconds, when time is very valuable, and thus cause much damage.

This warning may be needed in cases in which such need is least suspected, for the following reason. An engine may nearly always carry a light load, causing the flyballs to move on a high plane, and allowing the centerweight to travel through a limited vertical space. Long service under these conditions results in a very easy movement of these parts through their ordinary limits, but when moving below these limits they may not move so easily. This difference would only be noticed when the engine is started, and not then unless the engineer is especially careful to observe the details of operation, for the only difference is that the flyballs must be given a higher speed than if there were less friction. Even this may not exceed the highest speed attained under common conditions. After steam is shut off by closing the throttle valve, and the centerweight is moving downward, it may show irregular motion, but as this cannot affect any other part, it may not attract attention.

Fig. 8 shows two views of a governor

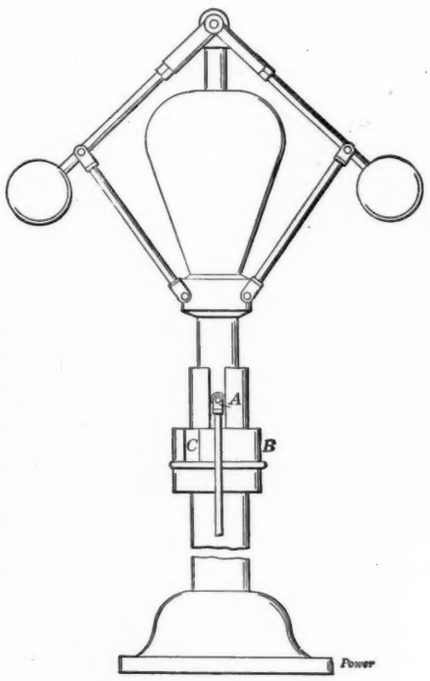


FIG. 7

equipped with a stop that is automatic in both directions. It is shown in running position. Steam from the bonnet of the throttle valve is carried through the small pipe *A* into the disk *B*, where it operates on a device similar to the Bourdon spring in a steam gage, which throws *C* out of a vertical position, as shown. Therefore, the bolt *D* cannot rest upon it, if the centerweight is falling to its lowest position should the governor belt break or come off the pulley. Consequently the stop operates and steam is shut off from the cylinder.

When steam is shut off by closing the throttle valve, pressure falls in the pipe *A*, which is piped to the steam chest or to the throttle valve under the disk; hence, the spring inside of *B* carries *C* into an upright position just in time for *D* to rest upon it. When the throttle valve is opened again pressure begins to rise in the pipe *A*, but it is not sufficient to throw the lever *C* over until *D* is lifted from it by the action of the flyballs, thus requiring no attention from the engineer. *F* is a dashpot which prevents the centerweight from moving too rapidly.

The small pipe *A* carries pressure to *B*

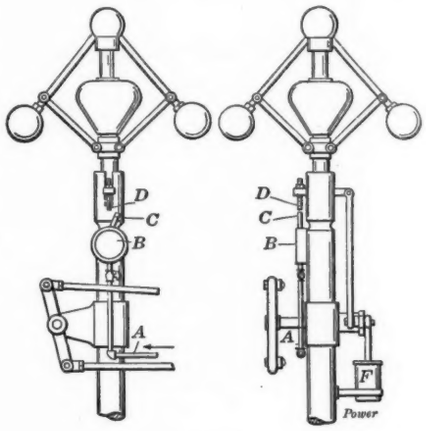


FIG. 8

when the throttle valve is open, but when closed, pressure is shut off from the stop.

A peculiar governor is illustrated in Fig. 9. Centrifugal force, caused by high speed, throws the governor balls outward, and the bell cranks, to which they are fastened, raise the sliding sleeve which operates the long bell crank pivoted at the left-hand side of the governor. This

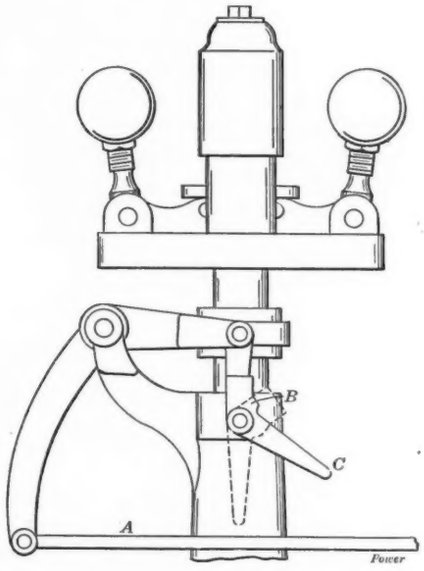


FIG. 9

gives motion to the horizontal rod *A*, and as it is connected to the tripping devices on the valve gear, it gives a long or a short point of cutoff according to the load carried. The cam *C* is shown in mid-position. When the engine is about to be shut down the long arm *C* of this cam

is raised to a horizontal position by hand, hence the short arm *B* stands vertically and receives the projecting part of the governor. When the engine is started again and centrifugal force throws the flyballs outward, and the cam, being lib-

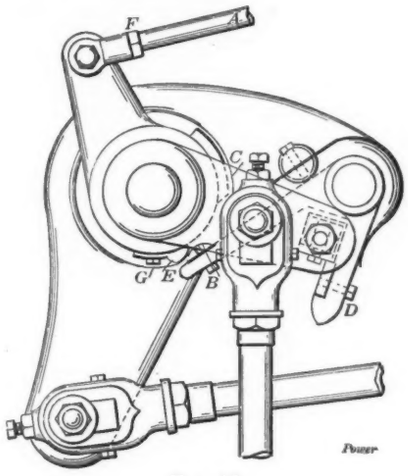


FIG. 10

erated, drops to the position shown by the dotted lines.

Every engine stop ought to be given a practical test at frequent intervals (say once each week), to prove that it is in working order. For illustration, take a Corliss engine with a flyball governor.

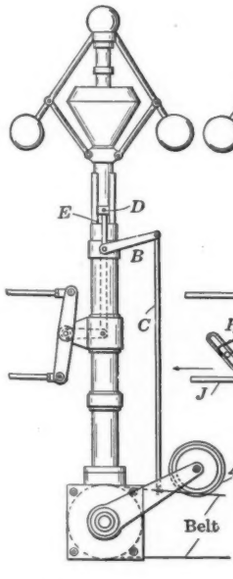


FIG. 11

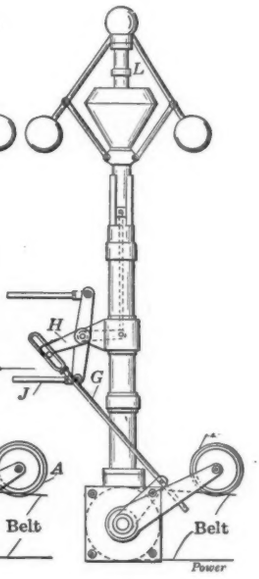


FIG. 12

Close the throttle valve until there is just enough steam admitted to maintain full speed. Suddenly force the flyballs down to their lowest position and keep them there for a few seconds by holding a convenient part of the governor. The engine will run faster for two or three revolutions, and then gradually stop, provided the adjustments are properly made. If not, steam may be shut off from one end of the cylinder, and admitted to the other, but this will not give excessive speed. If it is not shut off at both ends, make an adjustment that will give the desired result, but do not change the comparative point of cutoff, for if they are even they should not be changed, and if the condition of the valve gear in this respect is not known, an intelligent change cannot be made. It is usually possible to set the stop motion without changing the point of cutoff, but on the other hand, there are ways whereby both can be changed together, and it is plain that these ought to be avoided.

Fig. 10 illustrates this point, and shows the gear for opening and closing a Corliss steam valve. The reach rod *A* is adjusted so that when *B* is carried upward by the lifting arm, it will strike the knock-off cam *C* and the latch *D* will be

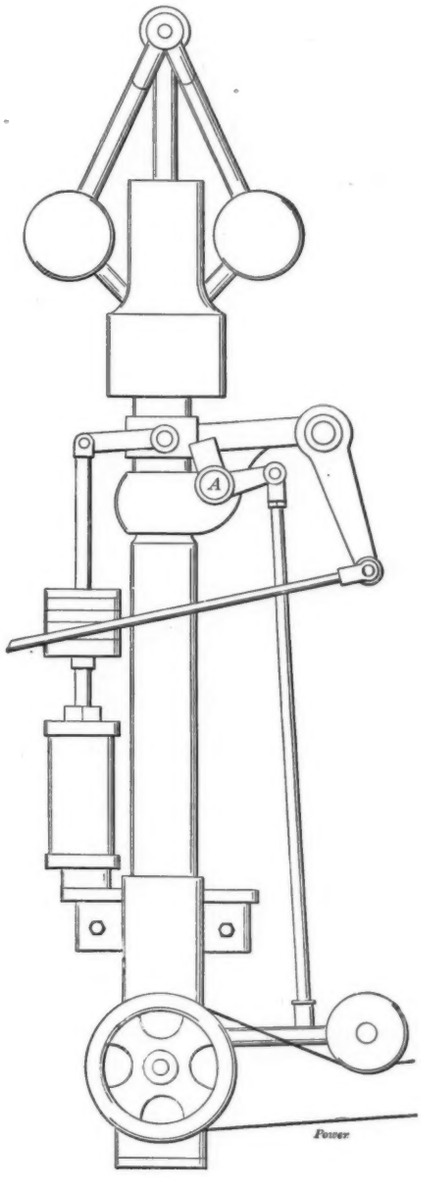


FIG. 13

unhooked and the dashpot will close the valve. If the flyballs of the governor of this engine should fall to a lower plane than at present, the reach rod *A* would be carried to the left, and the safety cam *E* would move toward the right hand, striking *B* and preventing *D* from hooking on. Consequently the valve would not open and no steam could pass into the cylinder. It is possible for the valve

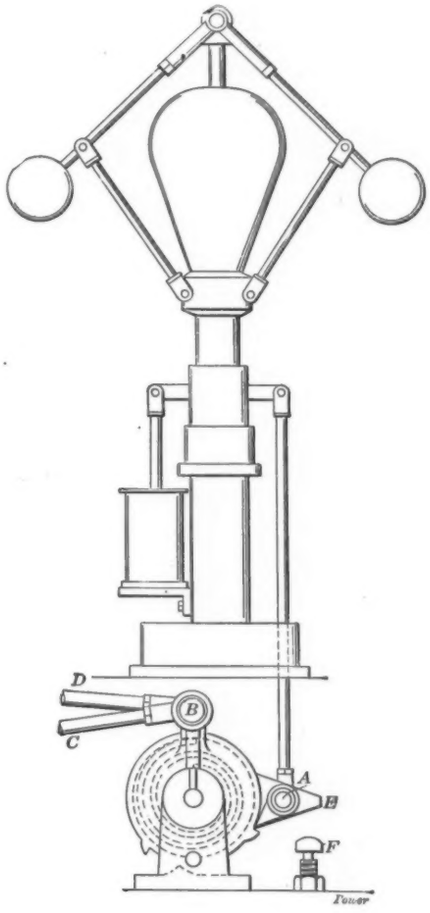


FIG. 14

gear to wear until *E* is no longer in proper position to prevent the valve from opening. A careless or thoughtless engineer will loosen the jam nut *F* and lengthen the reach rod until *E* will perform the duty for which it was designed. This action causes *C* to be moved from its proper position until it no longer disengages *D* at the right moment, resulting in an uneven cutoff for the engine, assuming that it was even before. The correct way is to let *F* remain as it is, and loosen nut *G* and slide *E* into proper adjustment and then screw *G* tightly down upon it.

An automatic stop which needs no attention from the engineer when starting or stopping his engine is shown in Fig. 11. The pulley *A* rides on the governor belt. The bell-crank lever *B* is kept in the position shown, by means of the long vertical rod *C*, as long as the governor belt remains in place. The flyballs and centerweight are in position to give the longest point of cutoff to the steam valves, as the projecting pin *D* rests upon *E*. When the load is reduced, *D* rises, but *E*

remains in position. If the governor belt breaks, *A* falls, *B* is also lowered and *E* is carried toward the right, therefore *D* goes lower than shown, and steam is shut off because the steam valves do not hook on and the engine stops. An important feature of this device is that if

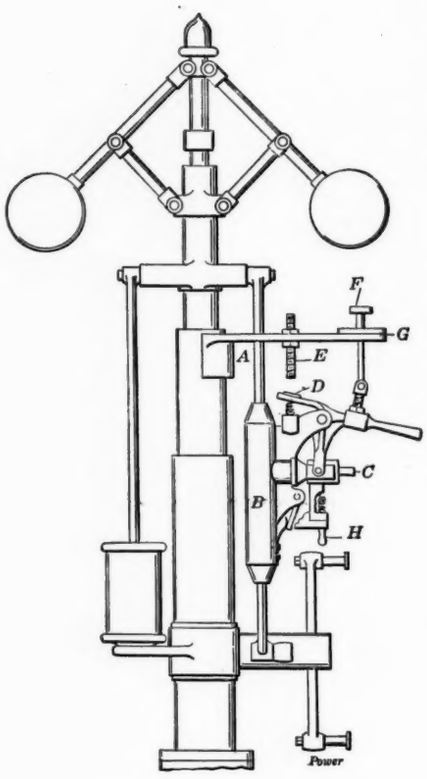


FIG. 15

an overload is put upon the engine it will not be shut down. On the other hand, if the governor ceases to revolve for lack of lubrication or any other cause, and the belt remains on the pulleys, steam will be admitted full stroke to the cylinder, causing excessive increase of speed.

Another stop is shown in Fig. 12. The governor is shown with a medium load on the engine. The pulley *F* rides on the belt and during ordinary service this pulley does not change its position, consequently the slotted rod *G* is practically stationary. If more load is added the centerweight is lowered, also the right-hand end of the lever *H*, the opposite end of which moves upward in the slot. The lower reach rod *J* moves as indicated by the arrow. If the load becomes lighter the centerweight rises and the upper reach rod is carried toward the left, shortening the cutoff. The same action takes place when the governor belt breaks, because *F* falls, and the slotted rod *G* is drawn down until the end strikes the pin in the bent lever *H*, the effect of which is to force the centerweight upward, shortening the point of cutoff until it is reduced to zero and the engine stops. The collar *L* must be set high enough to allow the centerweight to rise as described, but no higher. As the flyballs rise to operate the stop motion, the pulley *F* and its connecting levers must be heavy enough to overbalance the centerweight, flyballs, etc. With this gear the knock-off cams are utilized for safety cams, but only one set is required for both operations.

Fig. 13 represents another stop depending on an idler for its operation. As long as the belt supports this idler the engine cannot be shut down by an overload, but when the belt fails the cam *A* is reversed, and is no longer in a position to support the centerweight of the governor, consequently when it falls as low as possible, the valves remain closed and the engine stops. This device acts quickly because no load is put upon the idler and all of the mechanism connected to the idler tends to carry it downward when the belt breaks.

A flyball and centerweight governor attached to an ingenious device which operates the cutoff mechanism, also the

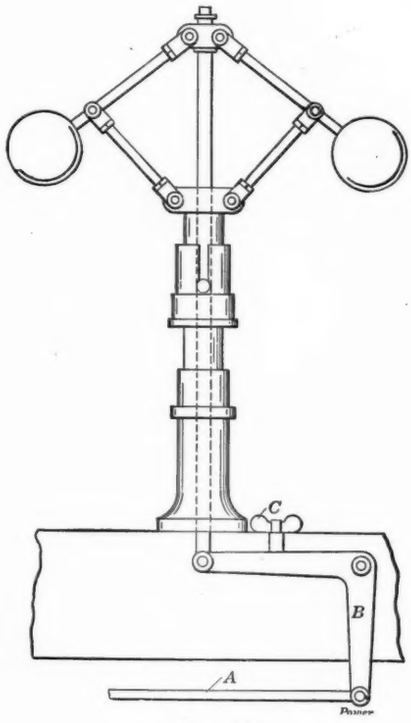


FIG. 16

stop, is shown in Fig. 14. The main parts of this device consists of two disks designated as rear and front, both of which are hung at the center. The rear disk *A* is attached directly to the governor by a vertical rod. The front disk *B* operates the two reach rods. Under normal conditions these disks move together, and transmit the motion of the governor to the cutoff mechanism.

The flyballs are shown in position for a medium load on the engine. If the load is reduced the balls and centerweight move upward, rotating the disks from right to left. This demonstrates that if *C* and *D* are carried to the left the cutoff is shortened, therefore if they are carried far enough the steam valves will not open. Increasing the load causes the centerweight to fall, carrying *A* downward until the pawl *E* rests on the adjustable

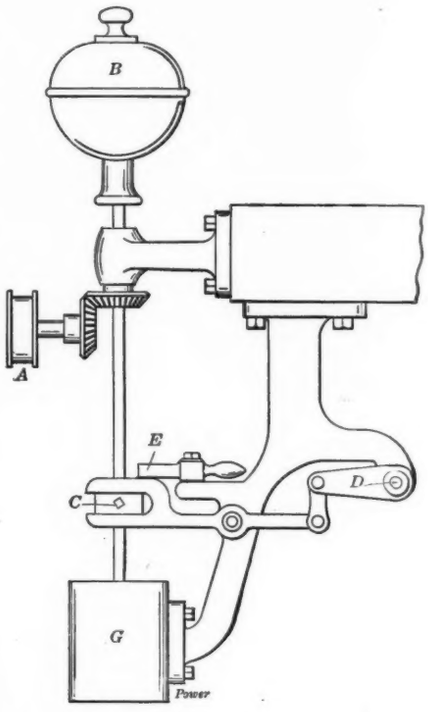


FIG. 17

screw *F*, causing *E* to release the front disk which is quickly thrown to the left by a strong coil spring. This action rolls the cutoff cams until they prevent the steam valves from opening. But one set of cams is used to designate the point of cutoff in regular service, and to prevent the valves from opening in case of accident to the governor, without raising the centerweight.

To prevent the stop motion from operating when the engine is shut down under normal conditions, a pin is inserted into both disks, thus locking them together. When the engine is started again this pin is thrown out automatically, thus making it impossible for the engineer to leave it in place, and render the stop useless.

A more complicated form of stop is shown in Fig. 15. The rod *A* corresponds to the ordinary side rod on a governor, except that its length is variable, and to shorten this length is the sole object of the device, because this section throws the ordinary reach rods to their extreme position and steam cannot be admitted to the cylinder. The enlarged part of the rod *B* is hollow and fitted with a strong spiral spring which tends to shorten the rod, but the pin *C* extends into this hollow part and prevents the operation of this spring.

Suppose that the valve gear is deranged and the engine starts to "run away." The flyballs rise carrying the spring-supported lever *D* upward until it strikes the stationary stop *E*. As *D* is depressed by this action, *C* is withdrawn from *B*, and the inclosed spiral spring draws the reach-rod lever upward, shortening the point of cutoff to zero (without carrying the flyballs higher) and as steam cannot enter the cylinder, the engine stops.

During ordinary service the rod *F* slides freely in the plate without interfering with the action of the governor in regulating the engine speed. However, if the belt runs off, the flyballs drop to a lower plane, and the movable part of the device is lowered until *F* rests upon *G*, thus pulling *D* down as before, drawing *C* outward and allowing the concealed spring in *B* to draw the reach-rod lever up until the point of cutoff becomes shorter, and finally is reduced to zero, stopping the engine. When preparing to shut down the engine in regular service, the stop is rendered inoperative by adjusting the plug *H*, thus enabling the engineer to stop and start at pleasure. When the engine is started again the flyballs rise and liberate *D*, which action throws *H* back automatically into the position shown.

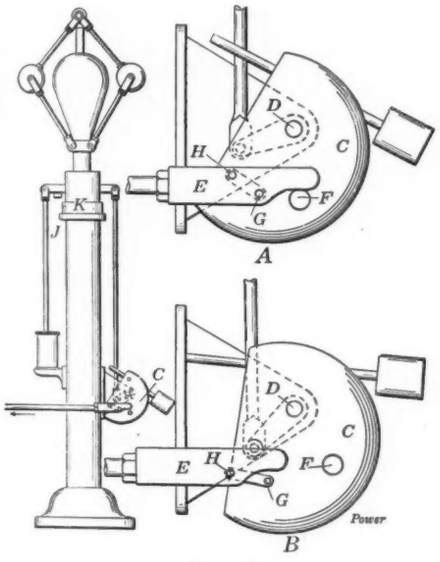


FIG. 18

A very simple device for operating a stop is shown in Fig. 16. As the flyballs drop the rod *A* is carried toward the right by means of the bell-crank lever *B*, and this prevents the steam valves from opening. A slot is provided in the frame for the thumb nut *C* allowing it to move freely vertically as long as it remains in the position shown, but if it is turned at right angles to this position it cannot pass through the slot. While turning the thumb screw prevents the device from operating in case the governor belt breaks, it is necessary to do so in order to operate the valves while starting and shutting down the engine. If the thumb nut is not set in the running position the device is no longer a safety attachment.

Fig. 17 illustrates a governor which is set low on the engine frame. The pulley *A* is driven from the crank shaft by a belt and bevel gears transmit motion to the vertical shaft on which is mounted a pair of flyballs inclosed in a iron case *B*. If this belt breaks, the flyballs come to rest, and the vertical shaft is drawn upward, the revolving collar *C* moving with it, thus turning the side shaft *D* through part of a revolution. This action prevents the steam valves from opening.

This stop will not operate while the hand lever *E* is in the position shown, because it prevents *C* from rising, but when given one-quarter revolution *C* is at liberty to rise. A dashpot *G* prevents *C* from rising and falling rapidly.

Another type of stop and its operating mechanism is shown in Fig. 18. Two views of the tripping device are shown at *A* and *B*; *A* shows the position taken with a light load on the engine. The half circular plate *C* is carried by a short shaft. The reach rod *E* rests upon the pin *F* and is held there by gravity, also by action of the link. The pin *G* is set into the reach rod and *H* is a similar pin set into the plate *C*. Therefore the stress upon the rod in the direction of the arrow will hold *E* more firmly on the pin *H*.

If the governor belt breaks, *J* is lowered into the slot in the movable collar *K*, and the action is further illustrated by *B*. The plate *C* has turned toward the left until the pin *H* is lower than pin *F*, causing the link to reverse its position, thus moving *E* toward the left twice the length of the link, which is sufficient to operate the stop.

A stop operated by electricity is shown in Fig. 19, used in connection with a Corliss governor, but it is suitable for several other types of valve gear. Steam at boiler pressure is admitted to the angle valve *A* which is closed under normal conditions. When the crank-shaft speed exceeds the limit for which this stop is set, a special governing device closes the electric circuit *B* and the armature *C* releases the lever *D*. This action allows steam to open *A*, when it passes through the check valve *E* into the vertical cylinder *F*, causing the piston *G* to rise and the rod *H* to lift *J* until the collar *K* prevents it from going higher, thus raising the flyballs to their highest position, and rolling the knock-off cams on the valve gear so far around that they prevent the steam valves from opening.

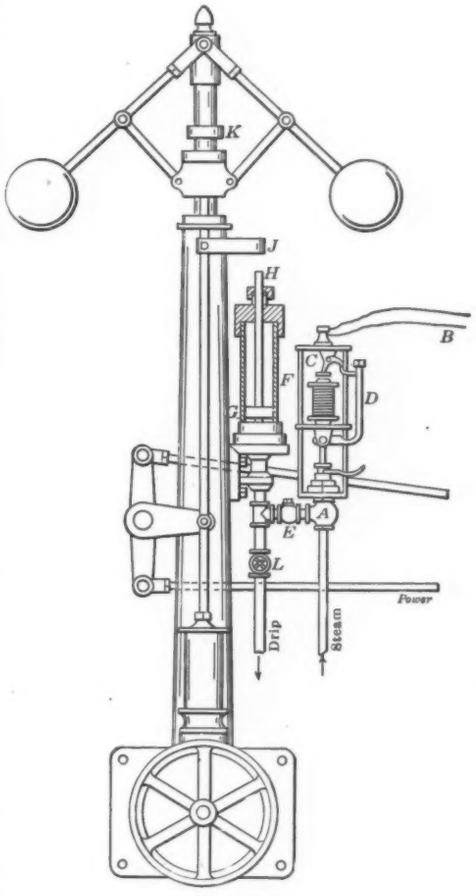


FIG. 19

When *D* is replaced, *A* is closed, and by opening the drip *L* all pressure is released from *F*, thus allowing the piston *G* to resume the position shown, when the stop motion is ready for service. Then the throttle valve is closed, the steam valves hooked up, and the engine is ready to start.

It has been stated that the exhaust from a gas engine will, if passed through a suitable exhaust-gas boiler, evaporate from two to two and one-half pounds of steam per brake horsepower-hour. Where the steam can be used this marks a substantial economy, and one would expect such boilers to be popular. As a matter of fact, very few are in use. One reason is, undoubtedly, that these boilers are subject to serious corrosion in many cases, particularly where, as frequently occurs, cold water is used for feeding the boiler. If, in addition, the boiler is shut down at week ends, it may be very cold when starting and will sweat. The exhaust gases being corrosive—especially if producer gas is used—a dilute acid is formed which has serious effects on the plates. A method of partially overcoming this corrosion, which is not often used, consists in feeding the boiler with water from the jackets. This water is, perhaps, at 120 degrees, and its temperature prevents sweating. On the other hand, there is no hot water when the engine first starts after a prolonged stoppage, and unless the boiler can wait half an hour or so some artificial means of heating the boiler should then be adopted.

Gas Power Department

Modern Governing Mechanisms

By Warren H. Miller

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

Of the various governing systems used by European and American builders of gas engines the means for varying the explosion pressure, and consequently the mean effective pressure, may be classified as follows:

1. Constant volume of charge and variable ratio of gas to air.
2. Constant ratio of gas to air and variable volume of charge.
3. Variable ratio of gas to air and variable volume of charge.

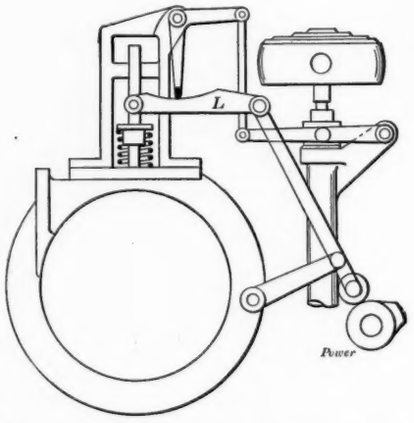


Fig. 1. Otto-Deutz Movable-fulcrum Gear

For small engines means for simply varying the stroke of the inlet valve will answer for regulation by varying the quantity of a constant-ratio mixture, and this is used in the original Deutz gears illustrated in Fig. 1. The governor alters the position of the fulcrum of the inlet-valve lever *L* and thereby changes the stroke of the inlet valve. In large engines, however, it is usually not practical to depend on the stroke of the inlet valve alone to determine the quantity of mixture admitted, without imposing too much work on the governor and robbing it of its sensitiveness, or else incurring the liability of the valve to reopen under the suction when only light charges are to be admitted. For this reason nearly all the large governor mechanisms include a mixing valve through which the governor controls the mixture, in addition to the main inlet valve for admitting the charge to the cylinder and keeping it there. Fig. 2 illustrates the Deutz mechanism used on large engines, the engraving being made from a drawing of the 2000-horsepower size. The governing is by throttling and the volume admitted is controlled, as in the small engine, by means of the movable fulcrum; shifting the fulcrum *f* alters the stroke of a pair of balanced gas and air valves, and the fulcrum at the left of the air-valve spindle is also shifted, still farther altering the opening of the gas valve. The ratio of gas and air can be altered to suit the quality of gas by turning a hand-wheel which moves a sliding cage on the inlet-valve stem.

Fig. 3 shows the form of shifting fulcrum gear devised by the Nürnberg company for varying the opening of the inlet valve. The governor shifts the roller *R* and thereby varies the "leverage" of both the rocker arm *A* and the valve lever *L*.

Fig. 4 illustrates the cut-off governor gear of the Société Alsaciénne. It is somewhat similar to some of the American mechanisms in that it embodies a ported-cage mixing valve. The inlet valve has a constant lift. The mixing valve, shown in section in Fig. 5, is a sliding cylinder with ports registering with ports in the housing which open into the gas and air mains. It is divided circumferentially into air and gas ports in the correct ratio for the quality of gas used. This valve remains normally down, shutting the ports, as shown in Fig. 4. With each stroke of the eccentric rod operating the inlet valve, the valve is lifted until the ports register with those in the housing and latched in that position, allowing gas and air to flow through to the cylinder until the valve is released by a trip gear under the control of the governor; when the latch is tripped, the valve drops, shutting the ports.

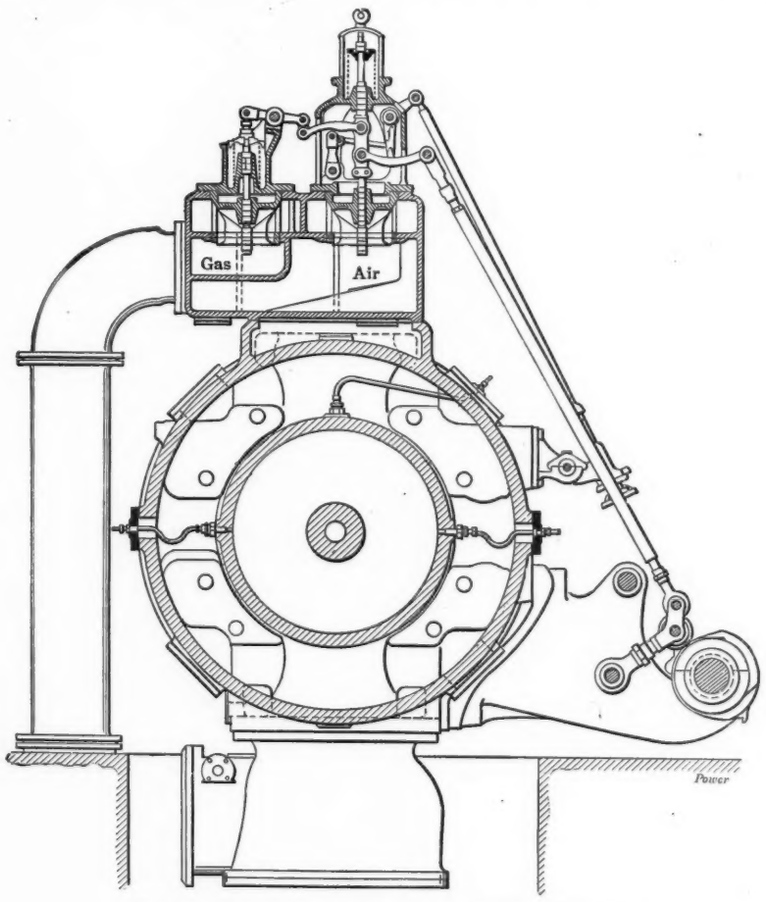


Fig. 2. Deutz Valve Gear for Large Engines

Fig. 6 shows the mixing-valve gear used on the large size of the Nürnberg engine, which is probably more familiar to American engineers than any other

Continental engine. Air is admitted throughout the suction stroke and the gas is admitted toward the end of the stroke, both being shut off simultaneously at the end of the stroke. The quantity of gas admitted is varied by opening the gas valve earlier or later in the stroke; regulation is effected, therefore, by varying the quality of the mixture, the volume being constant. Fig. 6 shows only the mechanism that operates the mixing valve, of which there is one on each cylinder, placed midway between the two inlet valves, which have constant lift and are opened by the usual cam-rod-lever combination. A bifurcated arm *A* is pivoted at its fork ends to the outer housing and linked at the other end to one end of the bell crank *R* which is controlled by the governor. The valve-operating lever *B* is pivoted at its inner end to the cylindrical member *C*, which slides within another cylinder *E*, attached to the stem *S* of the valve; the lever *B* has a sort of rolling fulcrum on the arm *A*, and when the governor lowers the outer end of this arm, the "heel" of the lever *B* strikes the face of the arm *A* later in the stroke and therefore opens the valve later and reduces the explosive mixture. The lever *B* opens the valve by lifting the sleeve *E* through the medium of a dog *D*, pivoted to the plunger *C*, and this dog is tripped at the end of the suction stroke, no matter at what point the valve is opened. When the dog is tripped the valve is closed by the helical springs in the bonnet.

The governor gear of the John Cockerill company, of Seraing, Belgium, also belongs to the variable-quality constant-volume class, but the mechanism is so designed that it can be used for either quantity or quality regulation. Fig. 7 shows longitudinal and transverse sections of the Cockerill engine cylinder and the principal features of the valve gear. The inlet valve has constant stroke and a sliding air valve moves with it, so as to admit air synchronously with the opening of the inlet valve. The gas valve is mounted above the air valve on a concentric sleeve, and its actuating lever *L* is normally latched at the outer end by the dog *D*. When the push rod *R* is forced upward by the inlet cam it opens the inlet valve and at the same time compresses a spring in the housing *S* which is attached to the lever *L*. This would open the gas valve but for the latch *D*, and this latch is tripped by the governor sooner or later in the stroke, allowing the spring at *S* to open the valve. The valve is closed at the end of the stroke by the downward motion of the housing *S*,

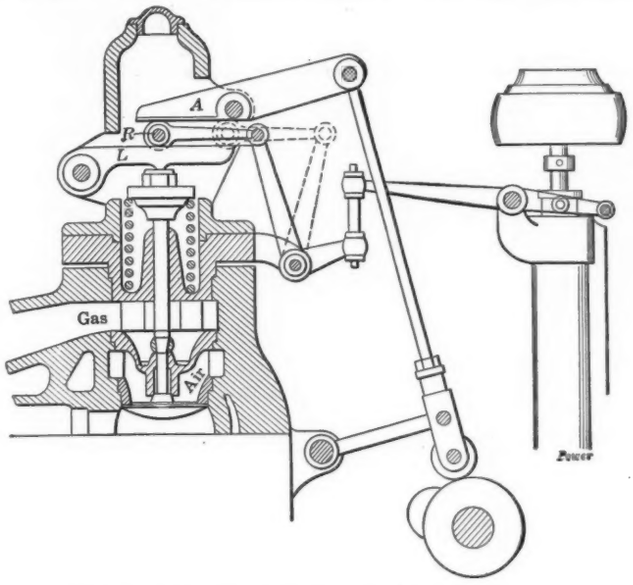


FIG. 3. SCHMITZ MOVABLE-FULCRUM GEAR

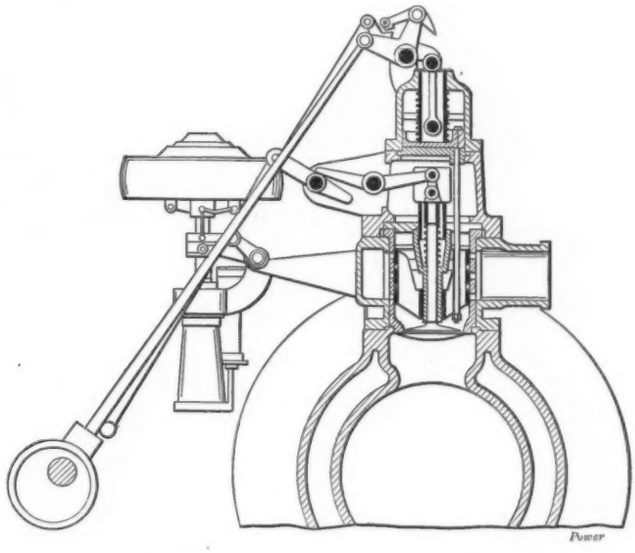


FIG. 4. ALSACIENNE VARIABLE CUTOFF GEAR

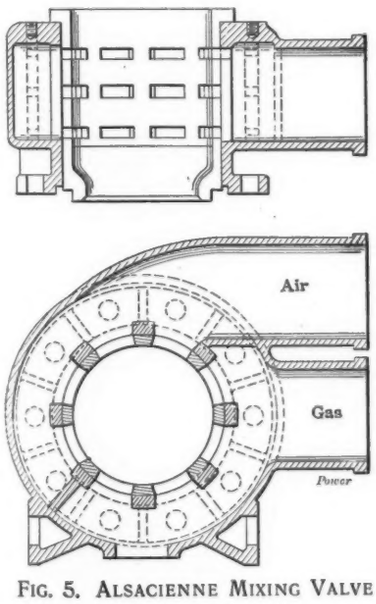


FIG. 5. ALSACIENNE MIXING VALVE

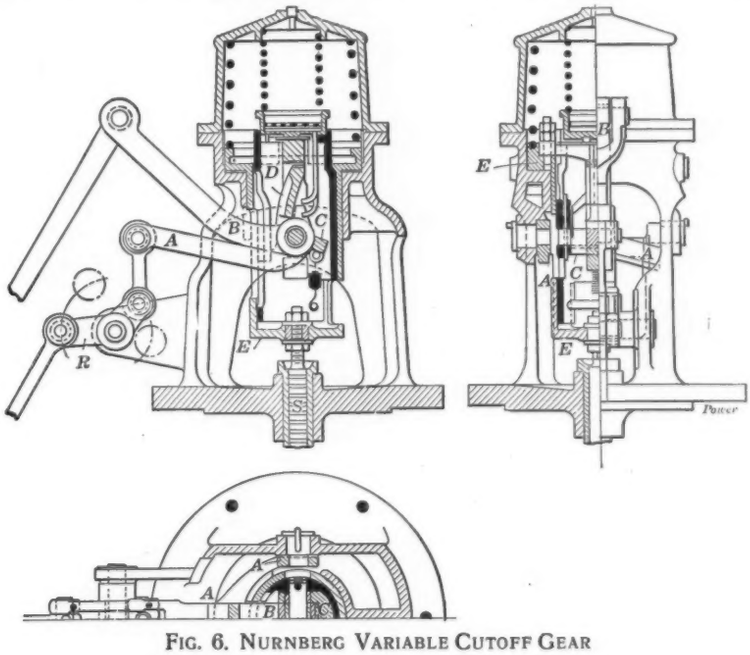


FIG. 6. NURNBERG VARIABLE CUTOFF GEAR

due to the fall of the push rod *R* when released by the main cam.

The tripping rod *T* is moved back and forth by a small eccentric on the main shaft, and its engagement with the dog *D* is timed by the governor through a mechanism which shifts the pivot of the intermediate rocker arm.

By extending the hollow spindle of check valve *N* prevents the entrance of air above the piston but allows the escape of any that may be there. A "bleeder" valve *J*, controlled by the governor, allows more or less air to enter the vacuum cylinder and vary the upward pull on the piston *P*. When the spring *K* is compressed by the downward movement of the inlet valve, it presses the gas valve to control both the area of the port openings and the length of time that they are open, without using trips or cutoffs. The sleeve *S* is twisted about the vertical axis by the governor rod, and the relative angular positions of its ports and those in the mixing-valve plunger are thereby varied. The mixing-valve plunger is attached to the upper end of the inlet-valve

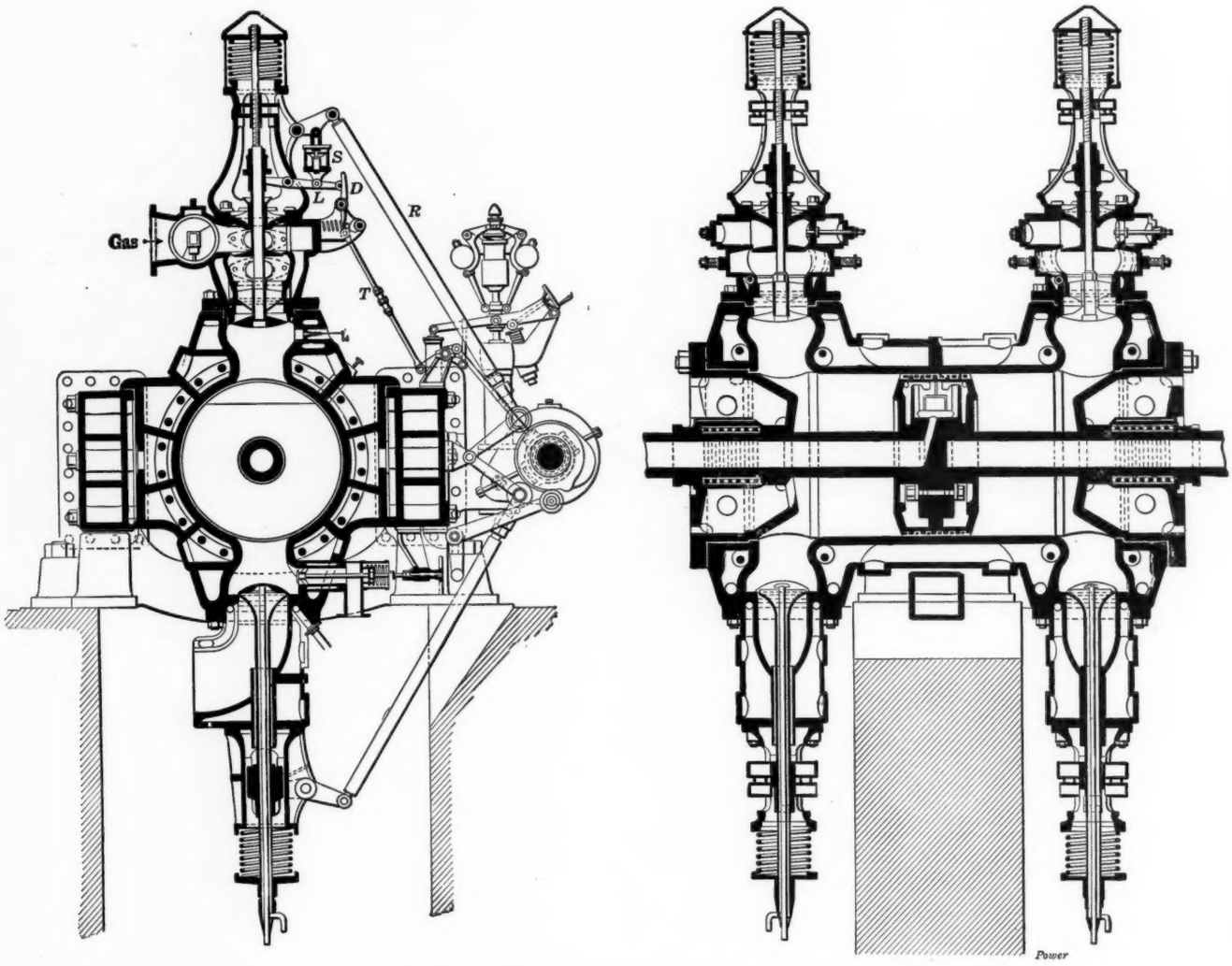


FIG. 7. VALVE MECHANISM OF THE COCKERILL ENGINE

the gas valve downward, unpinning the air valve from the inlet-valve stem and attaching it to the gas-valve spindle, the gear can be changed to quantity regulation.

A very interesting English gear operating on the variable-quality constant-volume plan is that of Crossley Brothers, shown in Fig. 8. The usual cam-rod-lever system opens the inlet valve against a spring. The nut *M* on the inlet-valve stem tends to carry the gas valve down with the inlet valve by compressing the spring *K*. The gas-valve disk *G* carries an upward cylindrical extension *H* which terminates in a vacuum piston *P* and incloses the spring *K*. A protected opening *O* allows air to pass in and out of the space below the piston *P*, and a open more or less, according to the amount of air admitted by the valve *J* and the resulting degree of vacuum that a given downward movement of the piston *P* can form above it.

As all of the American gears excepting that of the Bethlehem Steel Company's engine have been fully described in POWER, there is no need to discuss any but the Bethlehem gear in this article. Fig. 9 is a sectional elevation of the mixing-valve cage and shows also the inlet and mixing valves and the immediate operating mechanism. In this gear the ported cylinder attached to the inlet-valve stem which was first used in this country on the Westinghouse engine has been applied, but the ports are cut diagonally. This makes it possible for the governor stem and moves up and down with invariable stroke, under the pressure of the cam *C* and the usual seating spring, which is not shown here. At full load the ports in the housing sleeve register completely with those in the plunger, and since the total time that they connect is one-half of that for continuously-registering ports, the area of the ports must be twice as great to pass the same amounts of gas and air. When the load lightens, the governor shifts the sleeve *S* around so that at each stroke the ports in the sleeve and those in the plunger overlap less and less, until at very light loads they register only during the latter part of the stroke. As the ports are very wide and slant at a considerable angle, the governor has a very long "selective" range,

the total movement in an 800-horsepower engine being about 3 inches on the surface of the sleeve and 7 inches at the pin on the outer end of the arm.

This gear is the latest one that has been developed in American practice, and both this and the Westinghouse gears constitute an advance over English gears up to the present time in that they provide a variable cutoff without the use of any complicated trip arrangements or multiplicity of levers, links, cams, etc.

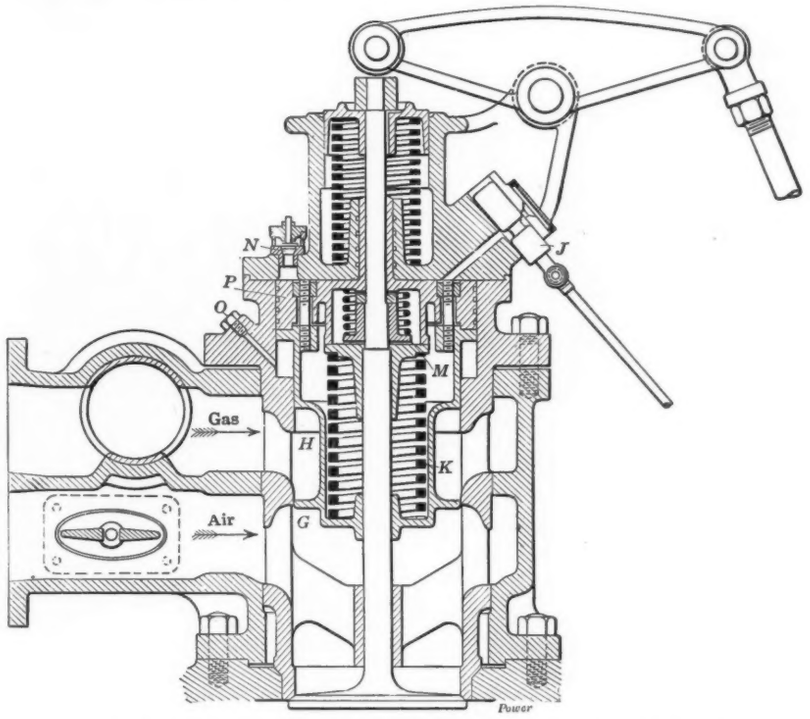


FIG. 8. CROSSLEY REGULATING MECHANISM FOR LARGE ENGINES

Sir William White's View of the Oil Driven War Ship

A recent issue of the *New York Herald* contained what purports to be an interview with Sir William H. White, who during the period from 1895 to 1902 was director of naval construction and assistant controller of the British navy. The alleged interview attributes to Sir William some statements which must have been either garbled beyond recognition or else supplied entirely from the reporter's imagination. Most of the reported statements, however, have a rather authentic ring. Following is the complete article published by the *Herald*:

"Yes," said Sir William H. White, "we have heard a good deal lately from writers in the press—not the scientific press—about the wonderful advance that is coming in the immediate future from the use of internal-combustion engineering in ship propulsion. I do wish that these gentlemen who spread such stories of impending violent changes in existing conditions would read the reports of the Gaseous Explosions Committee, which has investigated the subject carefully, and learn what the real difficulties are in the problem involved. It is really shocking, when one thinks of it, to read some of their maunderings.

"But perhaps all this piling of rumor upon rumor is accounted for by the fact that the 'silly season' is at hand. It has taken the place of stories about the gigantic gooseberry, of which we have not heard this year, or of the sudden and repeated appearances of the sea serpent, another old friend whose head has not been raised. We have had the funnelless battle ship rushing about again. It always will be so and does not matter much, I suppose, only it is to be regretted that when such a mass of scientific and experimental information is available for anyone who will take the trouble to read, these sensational and absolutely incorrect views of the present situation regarding internal combustion should be put before the public.

"I admit that if it were possible to concentrate the great amount of power now provided by huge engines which is required for the propulsion of a battleship into smaller engines such as one might imagine a motor-driven engine [!] would be, we should be getting to a position of tremendous possibility, but we are far from that position yet.

"Now, consider that point along with the fact that at the present time the most powerful petrol motors in serviceable use are from 100 to 120 horsepower. [Diesel engines of 1000 horsepower are built in Germany.—ED.] In those motors the amount of energy wasted is very considerable. [!] What would be the amount of waste if you were dealing with motors of 30,000 horsepower, and if you had the same proportion of waste? Where would you be? Work and experimentation are proceeding on scientific lines, and it is from that that our friends the physicists and chemists will be able to help us so much by showing the direction upon which such investigations may well be conducted.

"But the public should not be so deceived as it has been by such nonsense as the probabilities of getting in the immediate future a success which we hope and believe may ultimately be achieved, but in order to obtain which there must be much more experimenting, and in which there must be the most cautious advance.

"Of course, the report that the government was about to construct a motor-driven battleship represented an advance the importance of which, had the statement been correct, could not possibly have been overrated. But all this talk of the immediate running of petrol-driven battleships is sheer nonsense."

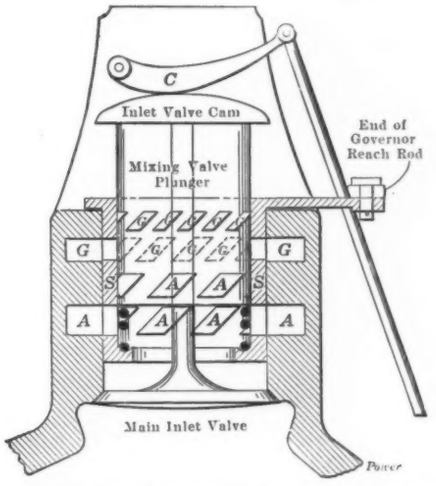


FIG. 9. BETHLEHEM MIXING AND INLET VALVE AND CAGE

Another Battleship Prophecy

According to cable despatches printed in the daily newspapers, German designers are at work on a small type of battleship which is expected to put the great "Dreadnoughts" into the obsolete class. The new vessels will be lightly armored and very speedy. In general design they will be similar to the old monitor. Their length will be 280 feet, breadth 46 feet and draft 19⅔ feet, while the hull will extend 59 inches above the water line.

The armaments will consist of two 16.8-inch guns, each capable of throwing a projectile of 5940 pounds from one great turret amidship. Four explosive gas motors, each of 6000 horsepower, will give the vessels a normal speed of 19 knots an hour and *under forced draft* [?] 27 knots. Ordinarily heavy plate will be placed on the decks, turrets and sides of the new vessel.

Electrical Department

Transformer and Switch Insulating Oil

By J. Vincent Hunter

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

There is hardly an electric-power station in the country that does not contain apparatus which depends on oil for some part of its insulation, and the investment involved in this apparatus is too great to permit the usual vague or limited knowledge of the proper care and treatment of this very important portion of a plant's material equipment. Oil is used for insulating and cooling of transformers, for interrupting the arc at the contacts of oil switches and circuit-breakers and for a number of minor purposes, and the same grade of oil can usually be employed with almost equal success in every case, provided proper care is taken in the selection of the oil.

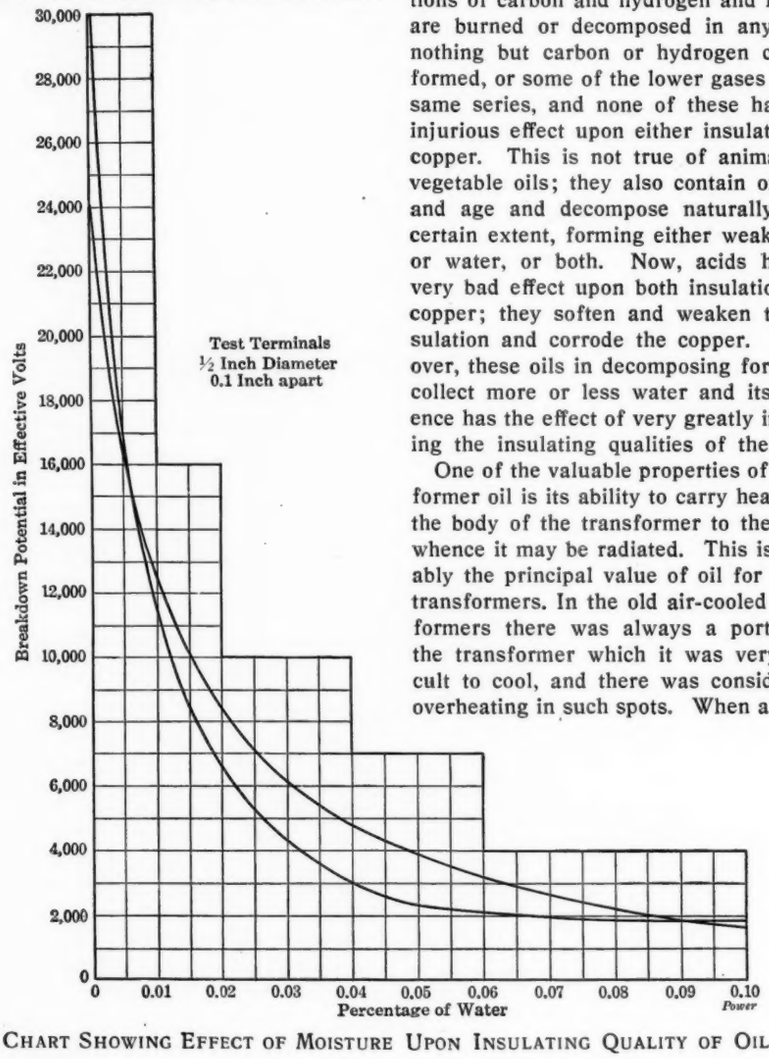


Chart Showing Effect of Moisture Upon Insulating Quality of Oil

The oil used for insulating purposes is an entirely mineral oil, distilled from petroleum and refined. No oils of either animal or vegetable origin can be used and their presence as an adulterant in transformer oil renders it absolutely unfit for use. Mineral oils are combinations of carbon and hydrogen and if they are burned or decomposed in any way, nothing but carbon or hydrogen can be formed, or some of the lower gases of the same series, and none of these has any injurious effect upon either insulation or copper. This is not true of animal and vegetable oils; they also contain oxygen, and age and decompose naturally to a certain extent, forming either weak acids or water, or both. Now, acids have a very bad effect upon both insulation and copper; they soften and weaken the insulation and corrode the copper. Moreover, these oils in decomposing form and collect more or less water and its presence has the effect of very greatly impairing the insulating qualities of the oil.

One of the valuable properties of transformer oil is its ability to carry heat from the body of the transformer to the shell, whence it may be radiated. This is probably the principal value of oil for use in transformers. In the old air-cooled transformers there was always a portion of the transformer which it was very difficult to cool, and there was considerable overheating in such spots. When a transformer is immersed in oil there is much less chance of this occurring. The oil acts in much the same manner that water does in a teakettle, and everyone knows it is impossible to burn the bottom out of a teakettle as long as sufficient water remains in it to cover the bottom.

Temperature Effects

In order that the heat may be carried away from the transformer body to the transformer case, it is necessary to have some circulation of the oil, but this comes naturally in the same way that circulation of water occurs in a tank when heat is applied at the bottom and the hot water rises to the top, while the cold water descends; in the same way the hot oil rises and the cold oil descends, keeping up a constant flow. From this it is evident that there must be circulation in order to keep the transformer cooled properly, and it therefore follows that an oil which would solidify at ordinary weather temperatures would not be suitable for this work. It is, therefore, customary to use an oil which will not solidify at a temperature above 20 degrees below zero. This is a lower temperature than usually occurs even in many of our Northern localities, but should the oil in a transformer freeze up at so low a temperature, the heat generated in the core when the transformer is in service would tend to warm the oil to a flowing point.

As already stated, transformer oil is distilled from petroleum; it is of the same series as gasolene, kerosene, naphtha, etc., though of a considerably higher boiling point. Its specific gravity ranges from about 0.82 to 0.825 for a very light oil to 0.88 for a heavy oil. These oils are not inflammable at ordinary temperatures and in order to get them to burn it is necessary to heat them until a temperature is reached which is known as the "flashing point." At this temperature a flame applied to the surface will produce a momentary flash over the top of the oil, indicating that considerable vapor is passing off which mixes with the air above the oil to burn, but there is not enough vapor liberated at this temperature to make the flame continuous. Still further heating of the oil finally brings it to a temperature at which it will take fire and burn of itself. The flash point of transformer oils ranges from 265 to 375 degrees Fahrenheit and the burning temperature ranges from 285 to 425 degrees Fahrenheit.

It may be readily understood that if an oil has a very low flashing point it is apt to evaporate readily at a temperature produced by an ordinary heavy working load on the transformer, and will therefore require constant replacement. For this reason it is more desirable to use an oil of a flashing temperature high enough to prevent the loss by evaporation from running very high. To show what will occur with an oil of low flashing point, the writer made a test of an oil with a

flashing point of 278 degrees Fahrenheit; the loss by evaporation was 3.15 per cent. in 24 hours, when the temperature was maintained at 205 to 210 degrees Fahrenheit. As this is but little above the full-load temperature of a large transformer, the test indicates the possibility for loss of oil when the flashing point is too low.

Insulating Qualities

The insulating or dielectric property of an oil is a very important one and as it is the one which comes most prominently to the attention of an operating engineer it deserves a great deal of consideration. A good quality of oil is a very strong insulator; its insulation value will run somewhere in the neighborhood of fifteen to twenty times that of air, which is generally considered one of the best insulators available. There are factors, however, which may quickly reduce the insulating quality of an oil to less than one-tenth of normal without any visible change taking place; the most effective, and therefore the most objectionable, of these is the presence of moisture in an oil. It is a remarkable fact that the addition of so small an amount of water as one one-hundredth of one per cent. of the quantity of oil will reduce the dielectric strength of the oil to less than one-half, while the addition of one twenty-fifth of one per cent. will reduce it to one-tenth or less of its original dielectric strength. From this it will be obvious that it only requires a few drops of water to a gallon of oil to produce very serious reduction in the insulating value of the oil.

The danger due to the presence of moisture makes it important that a transformer when in operation or in construction should never be left standing open out of doors if there is any likelihood of rain, snow or dew, or any chance of any moisture getting into either the transformer casing or the oil, nor should transformer oil be stored in a damp place unless hermetically sealed, as sweating may occur which would cause moisture to collect in the oil.

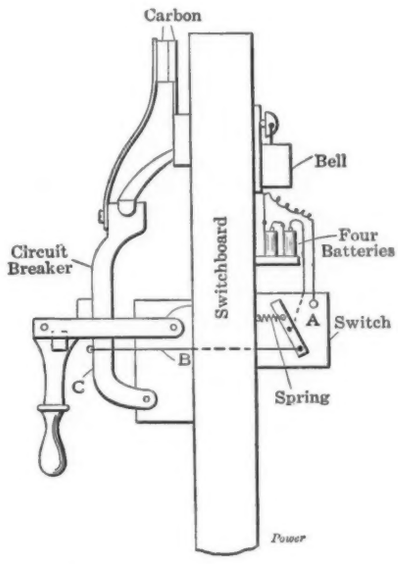
A good grade of oil will have a dielectric strength or electrical resistance to puncture sufficient to withstand a difference of potential of from 25,000 to 35,000 volts between terminals one-tenth of an inch apart, or, stated for a distance of two-tenths of an inch, which is customary, the value for this distance will range from 35,000 to 50,000 volts. The test for dielectric strength is usually made with ½-inch flat disks adjusted exactly one-tenth or two-tenths of an inch apart and covered with at least one inch of oil in the testing apparatus. Alternating current is always used for testing and it is usually obtained from a high-potential step-up transformer. The breakdown voltage is usually measured and recorded as the effective voltage indicated by the voltmeter at the primary terminals of the transformer, but the actual breakdown is probably caused by the instantaneous maximum voltage, and it is therefore desirable for such tests that a wave form as near as possible to a sine wave should be used. When the oil breaks down (is punctured), it does so with a sharp red flash or snap and this should not be confused with the slight static discharge which may take place between the terminals before the actual breakdown of the oil occurs.

To show the effect of moisture upon the dielectric strength of oils, the accompanying chart has been prepared, in which the curves indicate the breakdown voltages with different percentages of moisture contained in the oil, the test terminals being located one-tenth of an inch apart. The two curves here shown have been taken from different sources, and give practically the same results for moisture percentages below 0.01.

A Simple Circuit Breaker Alarm

By R. O. Warren

In electric-power plants of considerable size, a switchboard attendant is always on the watch to detect and correct anything that goes wrong on the switchboard, as well as to adjust voltages and put machines in and out of circuit. In small power plants, however, especially street-railway power houses, the engineer is switchboard attendant as well, and disturbances sometimes occur which interrupt the service by the opening of a circuit-breaker, while the engineer goes about his work in blissful ignorance that anything is wrong. This sort of thing happened so frequently in the power house of the North Carolina Public Service Company, Greensboro, N. C., that the engineer in charge installed the simple device illustrated herewith.



Circuit-breaker Alarm

On the back of the switchboard is placed a small switch *A*, the two terminals of which are properly connected to batteries and a good, loud, electric bell. A cord *B* is attached to the lower end of the switch lever, and passes through a hole in the switchboard to the movable contact arm *C* of the circuit-breaker. The cord is of such length that when the circuit-breaker arm goes wide open it closes the switch *A* and the bell rings until the circuit-breaker is reset. With this arrangement the engineer does not need to watch the circuit-breakers at all, because the bell is loud enough to be heard all over the plant. A spring pulls the switch *A* open when the circuit-breaker is closed.

LETTERS

Three Wire and Two Wire Generators

I have read with much interest the discussion of three-wire versus two-wire generators resulting from Mr. Smith's letter in the issue of August 23. I once operated a plant with a balancing set and to me it was not entirely satisfactory. The load was constantly changing from one side to the other with a consequent fluctuation in voltage. This made it necessary to change the rheostats at frequent intervals in order to approximate equal voltages on both sides of the neutral. Sometimes one side would be 115 and the other 105, and by the time they were equalized, the unbalanced load flopped over to the other side and the equalization had to be done all over again.

At present I am handling three-wire generators with one elevator, twenty or thirty motors and a lighting load. I have watched the voltmeters when the load is unbalanced and have never noticed over one or two volts difference on the two sides. At times the balancing coils are carrying about 50 per cent. of their full-load rating. From my experience I should prefer the three-wire machine to the two-wire machine with balancer.

G. F. Barker.

Dorchester Centre, Mass.

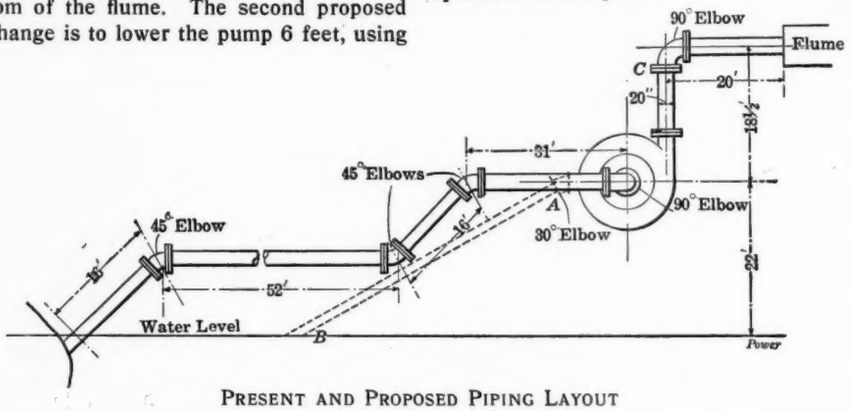
Japan is an ideal country for hydro-electric development because of its many rapidly flowing rivers. There are difficulties in the way of such development, however, not the least of which is the danger of earthquakes. Recently, it was proposed to build a large dam to furnish power for a generating plant of huge proportions, but fearing lest there might be a break in the dam caused by one of the earthquakes so frequently experienced in that region, it was decided to abandon the project.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Irrigation Problem

The accompanying sketch shows a pump connected up for rice irrigation and handling 16,500 gallons per minute. I would like to have the opinions of some of the readers of POWER as to the losses due to friction in the discharge and suction pipes with the pump in this position, also, what would be gained by the following proposed changes: First, if the pump were left in its present position and a ditch cut from the bayou to the point *B*, reducing the length of the suction from 115 feet to 60 feet, as shown by the dotted line; putting in a 30-inch elbow at *A*, and discharging directly into the bottom of the flume. The second proposed change is to lower the pump 6 feet, using the same construction of suction but reducing the length to 46 feet.



PRESENT AND PROPOSED PIPING LAYOUT

L. J. ROBERTSON.

Iola, La.

Specifications for an "All-round" Engineer

Some time ago, being out of a job, I decided to advertise for one, to which I received the following reply:

"We are in search of an engineer and electrician to take the place of our present man, who expects to leave soon. We have a plant containing two boilers, one high-speed engine, one Corliss engine, one 35-kilowatt alternator and one 65-kilowatt alternator. The 65-kilowatt alternator and the Corliss engine are operated regularly, the other unit being kept in reserve.

We want a man who throughly understands the care and management of boilers, engines and dynamos, and who can do all ordinary repair work on them. He must also be able and expect to do such house wiring as may be called for, and keep our street lights in repair. We have no arc lights, the town being lighted with incandescent lamps. The engineer has a fireman to help him, and they, being all the employees we have, are expected to do everything that is necessary to operate and keep the plant and system in operation and repair.

Our fireman is a negro and the engineer is expected to see that he performs his duties, and in the event that the fireman should be missing, the engineer would be expected to perform his duties, till someone else could be procured.

The plant runs from dark till daylight and the engineer is required to be at the plant from starting time till 1 a.m., the fireman remaining the rest of the night. We require the engineer to make daily reports to the office on printed forms, provided for that purpose, and we want someone who is willing to keep up with our report system. We want a man who will feel an interest in the plant and the success of the company, and who will devote his best energies to that end. He must be able to climb a pole, or do any other work that may be necessary around such a plant or system.

Our company has not a large income and for that reason we cannot afford to pay a large salary, but we are always willing to recognize good services. We are paying our present man $60 per month. If you feel that our conditions are not too burdensome and that you would be willing to undertake them, we would be glad to have you write us, giving responsible references."

G. J. PLACE.

Bridgeport, Conn.

Feeding a Boiler

The usual method of feeding a boiler is to have the feed pipe enter the front head just above the top row of tubes and extend to within about 3 feet of the rear head, where it crosses over and discharges through an elbow between the tubes and the shell. A much better way, however, and one that has been in successful operation at our plant for some time, is to have the feed pipe enter the front head in the usual place but extend into the boiler only about 2 feet, where it crosses over, discharging through a pipe capped at the end and into which has been cut a ¼-inch slot which will allow a flat file to be used for cleaning out the pipe. This is the coolest part of the boiler, and scale trouble is considerably lessened.

A. RATHMAN.

Chicago, Ill.

Check Valves in Cylinder Drains

To drain the steam chest, cylinder, etc., of a steam engine, it has been the practice to run a pipe from each chamber to one main drain which leads outside of the building or into the sewer. This requires a globe or an angle valve in each pipe as close as possible to the cylinder or chest to be drained, often making them almost inaccessible. This frequently results in careless engineers opening just one or two drains which are within reach, and often these are the ones that do the least good. In a compound engine there are usually six or more globe or angle valves in the drains, and in a duplex pump there are as many as twelve in the steam and water ends combined.

A much better plan is to use check valves instead of the globe or angle valves and place them close to the chest or cylinder, only a short nipple being used. Then pipe all the independent drains into one main drain, placing the check valves with the lift away from the cylinder. Increase the size of the main drain to accommodate the number of drains entering it and place a large globe or angle valve so that it can be opened and closed by the engineer while standing at the throttle. An extension handle will come in handy for this. The check valves employed should not have over one-third the lift of the pipe size in inches, that is, a ⅜-inch check should have ⅛-inch lift.

By closing the main drain valve all the drains are closed simultaneously, and I have had no trouble in using this system on tandem or compound duplex pumps where 20 drains led into the main.

There might be fewer piston rods bent or scored if the simple drainage system were universally installed.

LEON K. PULLIAM.

Pensacola, Fla.

What Size of Reducing Valve is Required?

We are installing a steam-heating system in connection with our electric-light plant and naturally a pressure-reducing valve will have to be installed to supply live steam at times when the exhaust steam is not sufficient. I find a great difference of opinion among engineers as to the proper size of regulating valve to install. Our main steam header is 4½ inches in diameter and the regular boiler pressure ranges from 100 to 125 pounds.

The capacity of the heating main is 7000 pounds of steam per hour at 5 pounds back pressure and there will be times when we will have more than this amount of exhaust steam. To meet these conditions, pressure-regulating valves have been recommended, ranging from 1½ to 4½ inches.

We have one 14x36-inch Corliss engine running at 100 revolutions per minute and one 14x15-inch four-valve Atlas engine running at 200 revolutions per minute. The minimum amount of exhaust steam available will be when the four-valve engine is running alone at a light load of about 30 horsepower, at which it will require about 50 pounds of steam per horsepower-hour. This will make 1500 pounds of steam per hour plus the amount used by the duplex boiler-feed pump. Generally it will not be as low as this, as we do the city pumping and nearly always have one pump running which would make the exhaust more than double this amount.

It is my opinion that a 2-inch reducing valve would be about the proper size. In figuring the capacity of a 1½-inch pipe at 50 pounds boiler pressure I find that it will supply 7000 pounds of steam per hour at a little less than 6000 feet per minute. A 2-inch pipe having nearly twice the area will deliver about double this amount. Of course, there will be considerable friction loss in passing through the valve and for that reason I have selected the 2-inch size. On the other hand, there may be times when we will increase our back pressure and consume more than 7000 pounds of steam per hour, but that is a question quite remote and need not be given much consideration. A 4-inch valve would become badly wiredrawn after a short time due to the small opening which would be necessary in handling the average supply. I would be pleased to hear from the readers of POWER as to the proper size of valve to install and also their experiences with the piston and diaphragm types of pressure-regulating valves.

G. S. SPRAGUE.

Geneva, Neb.

Firing with Natural Gas

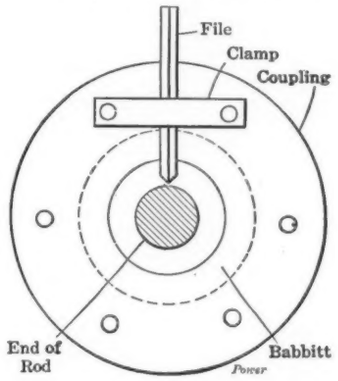
I would like to hear from some of the readers of POWER as to their experiences in firing with natural gas. I have three 150-horsepower return-tubular boilers, carrying 100 pounds steam pressure. What kind of burners gives the best results, how should the draft be handled and how should the firebrick be arranged in the furnace? What amount of gas is required per horsepower and how much water will 100 cubic feet of gas evaporate from and at 212 degrees Fahrenheit?

F. P. WILSON.

Grafton, W. Va.

A Homemade Lathe

Recently I was called upon to put in a new section of piston rod in a 7-inch steam feed in a sawmill, it being desired to lengthen the feed by 6 feet in order to afford a longer travel. The rod was 2 15/16 inches in diameter and hollow; one end was bored out and at the other



COUPLING AND FILE USED AS A LATHE

end a pin, made of a piece of threaded shafting, was shrunk on. When we attempted to screw the new section onto the pin we found that the latter was too large. Some way had to be devised to chase the threads, as filing did not seem to help matters any. The nearest machine shop was about 20 miles distant and it was imperative that the mill be in operation the next day.

While passing through the blacksmith shop I noticed half of an old flanged coupling and instantly devised a way out of the difficulty.

I took the coupling and drilled three or four holes in the hub to serve as anchor holes for babbitt. Next, I made a threading tool out of an old three-cornered file, and clamped this against the flange of the coupling. Then I put the coupling over the pin at the end of the rod, filled the bore with babbitt and gripped the device with a pipe wrench at the hub of the coupling and the lathe was ready for use. The sketch shows an end view of the lathe. Three cuts did the work. Of course, I had to cut just half of the pin at a time, and then take the coupling off and turn it around, and cut the other half, but the work was accomplished satisfactorily and the thread made to fit the new section.

N. HOWSE.

Bossier City, La.

Hot Discharge Pipe

A few days ago upon entering the compressor room I detected the odor of burning oil and began to look around and to feel the bearings, but found them all cool. The discharge pipe from the air cylinder is in an obscure place but I finally discovered that this pipe was red hot for a distance of about 4 feet from the cylinder. My first thought was that the cooling water had been stopped in some way and I began to think of what would happen if it should suddenly start again. I closed the throttle, then shut the valves of the cooling-water line and began to carefully look things over. I was surprised to find the air cylinder cool, so lifted the relief valve on the receiver and started the engine, running it without any air pressure until everything was cool.

I now closed the relief valve and ran the engine against 90 pounds pressure, and in about five minutes the pipe began to get hot again. I then shut down the engine and took off the cylinder head, and found the discharge side of the cylinder full of burned oil and ashes. Some dirt and rubbish must have gotten in regardless of the fact that there was a strainer in the intake.

It is my opinion that the area was so small that the excessive friction heated the air hot enough to make the pipe red. After removing two buckets of burned crust, I was bothered no more with the pipe heating.

M. G. FLETT.

Amherst, N. S.

Valves and Packing to Withstand Acid

We have about a dozen small pumps each pumping hot acids into large wooden tanks, and have tried hard-rubber valves with the result that after a few days some cracked and others broke into pieces, and at times the broken parts could not be found. Next, valves cut out of thick, soft rubber were tried; these would have lasted longer if they had not worn out so fast at the middle, around the valve-seat screw. We used flax packing for the pistons in the acid ends of the pumps, but this rotted out in about a week. Rings of thick, soft rubber were then tried but these wore off all way around and stuck to the cylinder walls.

Will some of the readers of POWER kindly inform me of anything that would

make more durable valves and better piston packing?

FRANK DEMARLE.

Barnards, N. Y.

Flywheel Trouble

A friend called upon me one morning to find out what was wrong with his engine, as the rim bolts of the flywheel were breaking and were liable to injure someone. Upon arriving at his plant I found an 18x42-inch Corliss engine running at 85 revolutions per minute, and pounding badly. We shut down the engine and found that the head-end steam valve had 3/8-inch lead and the crank end was set on a line with the edge of the port. This was the cause of the pounding and the breaking of the rim bolts. He claimed that the valves were set in this way to save steam.

This same engineer had a new feedwater heater but was too lazy to connect it up, preferring to take warm water from the building returns in winter and cold water in the summer.

WALTER W. SMITH.

Chicago, Ill.

Knockoff Cam Positions

Assuming that both knockoff cams on a Corliss engine are of the proper thickness to knock the hook clear off the block and are properly adjusted to give the right cutoff, if the governor is blocked in such a position that the long rod is at right angles to the head-end cam lever, then the short rod should bear the same relation to the crank-end lever. This leads to a question which may be satisfactorily answered by some experienced engineers who are readers of POWER.

Does the design of any Corliss engine allow shortening or lengthening of one of the cam levers? If not, then why could not one of them be adjusted in this way, so that the crank-end lever might be the shorter? In this way the engineer might be able to secure approximately an even distribution of steam either with a very light or a very heavy load. This shortening of the crank-end cam lever would balance the angular advance of the connecting rod.

LEROY WHEAT.

Emmetsburg, Iowa.

Should Water Be Used in Ashpits?

In the plant where I am employed as chief engineer, there are three Babcock & Wilcox boilers connected in one battery, each boiler rated at 150 horsepower. Every morning after the ashes are removed from the ashpits, I have the latter filled with water. The superintendent came through the other day and wanted to know why the water was put into the ashpits. I explained that the coal would burn better and would not clinker on the grates as badly with the water present as it would without the water. He replied that he had been a superintendent for fifteen years and had never heard of such a thing before; he believed that the water would injure the walls of the ashpits by softening the bricks and ordered me to discontinue the practice.

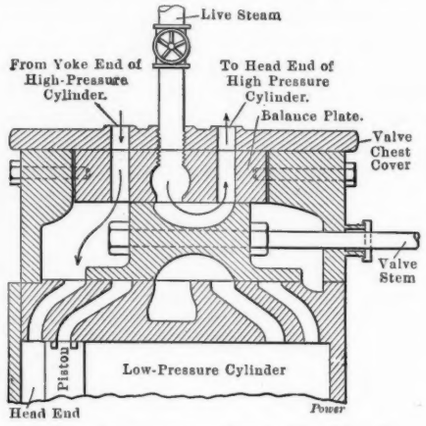
I would like to have the opinions of the readers of POWER regarding this. If the superintendent's statement is true, there is much money spent annually all over the country for replacing brick that has crumbled by the absorption of water from the ashpits.

HENRY PERLMAN.

Philadelphia, Penn.

One Valve Performing the Function of Two

I should like the opinions of some of the readers of POWER as to a proposed scheme for making one valve, in a compound pump, perform the functions which ordinarily require two valves.



SECTION THROUGH PROPOSED VALVE

This valve is to be located in either the high-pressure or the low-pressure steam chests and will be operated by the usual valve motion employed on the ordinary compound direct-acting pumps. There is only a pipe connection between the one valve chest and the other cylinder, no valve nor chest being required on this cylinder.

The accompanying sketch shows the valve as designed for use on the low-pressure cylinder. This design makes a neat and simple valve which can be made much cheaper than those of the present regular construction. It also produces a valve which is nearly balanced.

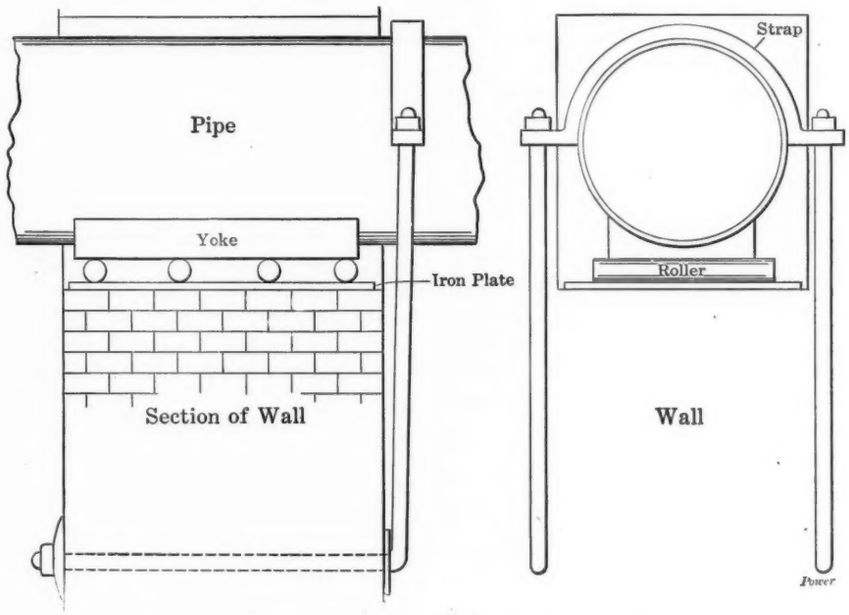
BERNARD U. POTTER.

Holyoke, Mass.

Flexible Pipe Brace

A 10-inch steam pipe about 40 feet long and connected to a 24x48-inch Corliss engine gave trouble by continuously vibrating in step with the strokes of the engine. A device was needed which would be sufficiently rigid to stop the vibration and at the same time flexible enough to allow the pipe to assume its normal position relative to its engine and boiler connections when either cold or hot.

A 16-inch wall separated the engine and boiler rooms through which the pipe passed. The hole around the pipe was made square and an iron plate was embedded at the bottom, as shown in the sketch. A yoke and rollers were then snugly fitted between this plate and the pipe. The wall was drilled and the bolts and strap placed as shown. It will be seen that there is sufficient clearance to allow the pipe to move in either direction under contraction or expansion while only enough tension is put on the bolts to stop the pipe from vibrating.



MEANS OF SUPPORTING PIPE TO PREVENT VIBRATION

F. C. HOLLY.

Yazoo City, Miss.

Questions Before the House

What Causes the Vibrations

Referring to E. S. Davis' inquiry in the August 9 issue under the above heading, I would say that probably the vibrations are caused by the impact and recoil of the steam due to the pulsations set up by the frequent starting and stopping of the flow of steam in the pipe and header, caused by the opening and closing of the valve on an automatic engine.

I have met with and overcome quite a number of cases of serious shaking of boiler headers and piping from this cause. It is not always easy to predict in advance from the piping layout of a plant when to expect vibrations severe enough to be troublesome or dangerous, the length and the size of the piping, the boiler pressure, and the speed of the engine, all have an influence on the result. I remember one instance in which the vibrations of the boiler and piping were quite severe, and it was considered that the piping was a little too small and that a larger pipe line would correct the difficulty, whereupon the line was replaced by one having 2¾ times the area of the old line. The vibrations were found to be more severe than with the smaller line, owing to the starting of the greater weight of steam contained in the larger line.

In the present case it is not so easy to understand why the vibrations should be much greater when using the No. 1 boiler than when using the No. 2, unless the dead pipe in the header when No. 2 is idle, acts as a compression chamber, or spring, to intensify the pulsations. If that is the case, the placing of the gate valve now over No. 2, against the end of the tee over No. 1 (where it should be to avoid dead pipe, if no more than two boilers are contemplated), would probably correct the difficulty.

I have never found a case that could not be cured by putting a sufficiently large receiver or drum at the throttle, thus allowing a comparatively constant flow of steam from the boiler to the receiver and permitting the violent starting and stopping action only through the throttle and a very short piece of pipe.

It is difficult to determine the exact size of the receiver; the speed of the engine, the character of the load, etc., each have an influence. It should be somewhere from four to fifteen times the volume of the cylinder. In the present case, I would recommend one having eight or ten times the volume of the cylinder.

G. A. Reichard.

Los Angeles, Cal.

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Conservation

A great deal is being said about the conservation of our natural resources and rightly so, also about the various acts of Congress regarding conservation. What can any commission do, if those directly interested do not lend their aid in every possible way?

In one of the large cities, a certain railroad, when it wishes to replace damaged or worn-out cars, removes the glass from the sashes, dumps the body into a lot and sets it afire. This applies not only to cars, but to all packing cases and refuse from their wood-working machinery. No doubt that company profits in some way, as it is known to be very efficiently managed in every department, but the fact that they do burn the wood means that quite a quantity of this material is utterly wasted. Could not this be utilized in some way? The above is only a specific case. I believe that it is the custom of most all of the companies to burn their discarded wood, amounting in the aggregate to quite a forest which is annually disposed of in this manner.

On the other hand, the same corporations are very careful as to how their coal is burned, and keep careful comparison records of coal consumption and output. The loss of a fraction of a pound per square foot of grate per hour would amount to a large annual loss unless such records were kept.

While a complete system of records is kept by practically all large concerns, a considerable number of engineers who operate smaller plants keep records, probably not on a very extensive scale, but sufficient to enable the engineer to compare costs from week to week and determine where improvement can be made. Such engineers are progressive and keep uptodate, by careful observation and by a thorough reading of the many valuable articles which appear in the technical press. Many go a step further and keep others posted on matters pertaining to their work. When they have accomplished anything they believe beneficial and of interest, they give the benefit of their experience to others. Such men have been responsible for the great strides made and wonderful results obtained in power production. While due credit must be given to the technical engineer, the actual work must be carried forward by the practical man. Each has his own sphere.

Getting back to conservation and coal economy, there is a large number of plants where the engineer has lost interest or gotten into a rut; where economy is not particularly the watchword; where boiler settings are not taken care of; where scale and soot are allowed to collect on the tubes with consequent high flue temperature; where comparatively low-temperature feed water is supplied to the boiler; where leaks in pipe joints are neglected as well as the engine pistons and valves; where possible advantage is not taken of the opportunity to use exhaust steam for heating, and where a very fair amount of power and coal is directly wasted. That engineer is a conservator who sees to it that full and proper use is made of all apparatus on hand and who trains his subordinates in such a manner as to insure maximum efficiency and economy.

W. E. Rector.

Brooklyn, N. Y.

Installing Globe Valves

There seems to be a difference among the engineers in general as to which way globe valves should be installed. I have had considerable experience along that line but I do not pretend to know it all. I prefer to have the pressure come on the bottom of the disk when possible, as this gives two chances to pack the valve stem, when the valve is shut and when it is wide open, provided the stem has a shoulder and makes a tight joint with the bonnet when opened as far as it will go. If the stem has no shoulder the valve can still be packed when tight shut, whereas, if the pressure is on top of the disk, the only time when it can be packed is when the valve is wide open, provided there is a shoulder on the stem, or when the pressure is off of the valve entirely.

In regard to the stripping of the threads from the stem, I have never had much trouble in that direction. What trouble I have had has been caused by applying a monkey wrench to the hand-wheel. I also believe that the opening of a valve can be set with a greater degree of accuracy, when it is wanted, say, one-quarter, one-third or one-half open, by having the pressure below the disk than when the pressure is on top.

For a boiler blowoff valve I prefer a

reversible, renewable disk, and a renewable seat. I do not care much for asbestos-packed cocks on boiler blowoff pipes, but do not doubt they are giving excellent service in some plants. I am trying an asbestos-packed cock on the blowoff from the water column and it has given good service so far.

GEORGE DREYER.

Gibsonburg, O.

Advantages of Compression

It would be hard to say anything new on this subject, but in the article under the above title in the August 30 number, Mr. Clarke gives a refreshing and sensible phase when he describes his regard for compression by calling it a "faithful servant."

It is probable that the natural dissatisfaction of the mechanical mind with anything short of exact knowledge has been the cause responsible for keeping this subject so persistently before the engineering public and it cannot be denied that the motive has been a laudable one. Although every phase of the matter has been gone over repeatedly, no universally accepted conclusion has yet been reached, and the diversity of opinion as to its economical status is still so great as to make it appear that we have been traveling in a circle.

I believe in the use of compression when it is needed. In practice, I use as little as possible, and would dispense with it altogether were it possible to do so, believing that the advantages for and against it are about equal, with the balance in favor of compression for its purely mechanical effect upon the journals and connections. By the practical operating engineer it should be regarded as simply one of the very useful and handy resources at his disposal to use or not, as taste or occasion indicates. This is a sort of neutral position between the opposing factions that should be taken by all practical men who aim to keep an open mind and who are wide awake to the best things developed on either side of the discussion of any subject, and it would seem that it is about time we all were getting into that position about this much mooted matter of compression, leaving the economical phase of the subject to the theorists and experts, who really seem to be the most concerned about it.

Perhaps no class of men appreciates the usefulness of compression any more fully than do those who are engaged in erecting engines. At the trial start of a reciprocating unit before the bearings are worn enough to be safely keyed to their final position for smooth running, compression is a valuable aid and often means the difference between a favorable and an unfavorable expression of opinion by the buyer and others interested who throng the engine room at such times.

In Corliss-engine work, especially where the compression can be varied to a considerable extent without affecting the economy, or, temporarily, for a greater extent to meet an emergency, by the simple manipulation of the exhaust rods, the convenience of this medium to help the engine quietly over the centers is greatly appreciated by the erector.

I once received hurry orders to babbitt the main journal of a 14x36-inch Corliss engine in a municipal electric plant. I found the superintendent anxiously awaiting and learned that the town had been in darkness the preceding night and part of the night before. By dint of hard labor the box was rebabbitted and a start made at about 5 o'clock. When the load came on a little later, my first impulse was to seek safety in flight, for the variety of pounding shocks and noises emanating from various parts of the engine would have turned a foundryman's rattle-box green with envy. However, a glance toward the superintendent and the fireman (the latter was also engineer), neither of whom seemed in any way disturbed, reassured me and I decided to stay and die game and when the fireman said, "She's running fine!" my courage rose to normal, although I could not help wondering what kind of a rolling mill "she" had been when not running fine.

Shying around the cylinder head I attached an indicator and obtained a diagram which had perfectly square corners. Slacking the jam nuts on the exhaust rods I lengthened both rods at once. The change made the engine room seem like a cemetery at midnight compared with its former state.

Although expecting the improvement in the engine, I was not prepared for the astonishment of the superintendent, who hurried to the switchboard, thinking his line was down.

This is only one instance in which compression proved to be timely and useful, but there are other instances that could be mentioned, less spectacular perhaps, but equally as interesting and illustrative of the fact that compression is a useful aid to invoke when needed.

The following day the valves were properly readjusted and other things corrected about the engine, obviating the necessity for as much compression as was used in the emergency.

Another side of the question is illustrated in numerous instances where the range of cutoff and, therefore, available horsepower, is seriously curtailed by too much advance of the eccentric to obtain an excessive compression where, if the engine were properly alined and adjusted, it would run better on much less. Frequently, the engineer in such cases is found to be so wedded to the high-compression idea that he thinks he cannot run without an excessive amount.

Mr. Clarke's letter with its account of the difficulties of steam engineering in the 'fifties is exceedingly interesting. It may be of interest to know that the millers of that period were not the only ones to hold the opinion that grain products were superior when ground by water power. In fact, at the present day there are many sections of this country where corn meal ground by steam power is only purchased when "water-mill meal" is not obtainable.

F. C. HOLLY.

Yazoo City, Miss.

Packing Condenser Tubes

Mr. Simpson's letter in a recent issue of POWER on the subject of packing condenser tubes suggests a method for doing this rather tedious job which, while undoubtedly faster than the old method, is very liable to cause trouble. The most essential point in packing a condenser tube is that the joint be absolutely air tight and at the same time allow sufficient movement of the tube to take up the contraction and expansion of the metal under changes in temperature. In the method used by the Wheeler Condenser and Engineering Company, of Carteret, N. J., and criticized by Mr. Simpson, the packing is inserted by using a hand tool and a light mallet which serves to tap in each portion of the corset lacing as it is wound into position. By this method the operator can feel his way and make sure that he is not winding the packing too tightly, causing it to twist or bind. The finished job is then an even, fairly tight coil of corset lacing which exerts sufficient pressure against the tube surface and tube plate to prevent the leakage of air and water and at the same time is not too tight to cause the tube to bind.

If, instead of this method, the method proposed by Mr. Simpson is used, namely, using a carpenter's brace to turn the packing tool, the corset lacing is liable to be wound in more unevenly and hurriedly, resulting in a poorly wound packing that twists and has uneven spots in it. The trouble when using a carpenter's brace is that the operator, unless very well acquainted with his work, will try to go too fast and do careless work.

The matter of proper filling for condenser packing is of much importance. Mr. Simpson proposes boiled oil as the most suitable filling or lubricant for the packing. Twenty years of study on the part of the Wheeler Condenser and Engineering Company has resulted in their determining that paraffin properly applied gives the best results and preserves the tightness of the joint for the longest period of time. Oil is liable to become rancid and break down into its organic acids which may cause corrosion of the tube plates and the tubes.

PAUL A. BANCEL.

New York City.

Cracked Cylinder

In POWER for September 20, C. G. Harrison asks about a cracked cylinder. I suggest that he read the various advertisements relating to welding and brazing that appear in the technical papers, especially the *American Machinist*. Then, write to one or two of the firms and explain fully the nature and size of the crack, giving a sketch if possible. They would, no doubt, advise brazing, and would give a figure on what the job would cost. The job could be done on a Sunday without the necessity of taking the cylinder off.

However, if Mr. Harrison wishes to repair the crack himself, I suggest that he uncover the crack and expose it on the outside, drill a ¼-inch hole at each end of the crack, then fit a patch, say about 3/16 of an inch thick and at least 2½ inches wide, over the entire crack. Drill this patch for 5/16-inch machine screws and, using it as a templet, drill and tap the cylinder to suit. Then mix some steel cement and work it well into the crack; apply the patch with cement and screw up tightly. I am sure that this will remedy the trouble.

Regarding the question, "Is it safe to keep on running with the cracked cylinder?" my answer is no. There is a possibility of the crack extending further and reaching a stage where repairs would be costly. Then, again, there is the constant worry. If the engine must be kept going, I would certainly take the time to offset the chance of the crack extending by drilling small holes at the ends and plugging them up.

GEORGE H. HANDLEY.

Newburgh, N. Y.

Trouble with a Pumping System

In the issue of September 20, the question is raised as to why a certain pump operated better when placed near a river than it did when at a distance from it.

Two suggestions are made as to the reason for the failure of the pump when placed at a distance from the stream, but can we not consider that both are practically alike and that one is merely the effect of the other?

As the writer says, there should be no trouble in raising the water 19 feet if the pump, valves and piping are all in good condition. But when the suction pipe is 900 feet long there must be many more joints in it than when it is only 50 feet long, and each joint makes the pipe a little less likely to be air tight. There is not only the long suction pipe, through the joints of which the air may leak, destroying the vacuum, but the vacuum must be higher to raise the water 19 feet than when it must be raised only 14 feet as in the second case.

There is also the probability that the piping and pump received some attention when the change in location was made so that they are now in better condition than at first.

G. H. MCKELWAY.

Brooklyn, N. Y.

In regard to the letter of inquiry by Mr. Kropidlowski in the September 20 issue, I think that the trouble must have been in the foot valve, otherwise the water could not have left the pump. If there had been any escape in the suction pipe, priming would have done no good. If the pump worked all right for several hours, it should have worked all right continuously if the power was kept up and the water level did not lower enough to uncover the end of the suction pipe. Of course, we all know that the shorter the suction pipe is and the fewer elbows there are the easier is the lift.

In all cases where the suction pipe is long, or the lift high, it is advisable to use long bends on the pipe instead of square elbows, as shown in the layout. If the strainer, shown in Fig. 3, got blocked with weeds or other material, it would stop the flow of water, but priming the pump would not do any good in starting the pump in this case, so the trouble could not have been due to this cause.

J. E. NOBLE.

Toronto, Ont., Can.

Centrifugal Pump Experience

In the September 20 issue an account was given of two centrifugal pumps that refused with criminal persistency to deliver water. The conclusion drawn seems to be that the only reason why they finally started was that they had made up their minds to do so. While familiar with the sometimes rather puzzling tricks of this style of pump, I believe that the solution in this case was a simple one. Probably the impeller was air bound. Owing chiefly to bad design, air will sometimes collect around the center of the impeller, allowing the water to be drawn up round the outside by the primer; and even when the primer is throwing a solid stream of water no amount of running the pump even at several times its normal speed will bring water to the discharge. The primer, however, will still continue to throw water. Shutting down the pump and letting the trapped air flow out, and (if it is a small enough pump) turning it backward, will cure this in an ordinary case. But in a severe one like that mentioned, the best way is to tap another primer connection in the pump casing as close to the center of the impeller as possible.

The fact that the pumps under discussion were always hard to start tends to bear out this theory, as evidently all of the piping was tight and every possible detail was carefully looked after.

Of course, it is taken for granted that the suction of the primer entered the highest part of the pump.

However, as these pumps finally worked, it could not have been a similar case to one that I once was called to remedy. A pump in a small plant just erected could on no account be made to throw water. A local machinist who installed it was evidently entirely unfamiliar with centrifugals. At first glance it was seen that the pump was running the wrong way. Upon being questioned as to why it had been installed in that fashion, he removed the suction elbow so as to expose the impeller and pointed out that the curved vanes seized the water like the buckets of a dredger and hurled it out. After trying to explain for half an hour the reason why the vanes were curved, which was listened to very doubtfully, I persuaded him to cross the belt, after which the pump threw the water at once.

O. MONTHAN.

Tucson, Ariz.

In the September 20 issue, W. N. Wing describes his experience with two centrifugal pumps in a very entertaining manner, and I certainly would like to assist him in his praiseworthy efforts to get the best of those temper-destroying pumps. In justice to these same pumps, I cannot help but state that, in my opinion, it was through no fault of theirs that they did not pick up the water. A centrifugal pump is not designed to pump air, and when it comes to pumping air and water mixed, when the lift is anything to speak of, it will surely balk. In regard to the particular plant where Mr. Wing experienced all of that trouble, I believe that the layout of the suction piping was faulty, that there were some places in this piping where air pockets could form. Consequently, when the pumps were started, there would be some air mixed with the water. The water, being much heavier, acted with greater centrifugal force and therefore took its place at the periphery of the pump, while the air remained at the center and destroyed the suction. The logical remedy was to move the siphon suction from the top to the center of the pump, or as near to the center as it is possible to have it, and on the side opposite to the suction. I have no doubt but that this would have started the pumps in good shape.

CHARLES L. ANDERSEN.

East Chicago, Ind.

Siphon Heating System

I was much interested in reading the description of a siphon-heating system in POWER for September 6. Some time ago I assisted in the installation of a similar system in a hotel at Niagara Falls. The system worked perfectly.

In this system the exhaust of several pumps led into one exhaust pipe, and the jet was coupled in the same way, as indi-

cated in the article referred to. The returns led back to a closed heater and at times we were much annoyed by a considerable back pressure forming in the heater.

This occasionally got so bad that it backed the returns into the lower tier of radiators. We found that a great deal of the trouble was caused by an irresponsible person fooling with a steam trap and leaving the bypass valve open. It seemed impossible to stop this, so the following plan was adopted.

A 2-inch pipe was coupled to the top of the heater and to the exhaust line just back of the siphon. This kept the heater free from pressure and tended to cause a vacuum in it.

The trouble with the returns stopped and we could heat the building with but the slightest pressure in the mains.

WILLIAM WATT.

Lambton Mills, Ont.

Engineers' Wages

In the September 13 number, C. R. McGahey has an interesting article on "Engineers' Wages."

After pointing out the difference between 'good" and "bad" engineers, he makes this statement, "Wages count for nothing. We cannot all be the president, but if a man amounts to something and puts his ability on the market in the proper way, he will receive a fair price for it." Will Mr. McGahey please tell us the proper way in which to market one's ability; what is a fair price, and how is it determined?

Further on, he writes, "Almost anyone can get into the National Association of Stationary Engineers. What is the result? Some of those who should wear a button in the lapel of their coat are somewhat ashamed to be a member." He objects to this purely educational organization because it admits to membership anyone who is willing to learn.

He next "takes a fall" out of the unions. He writes, "Some men are short-sighted enough to say, let us have a union, . . . this would mean that a good man would have to work for the wages of a poor man, in other words, equal wages." That statement is a gem. He tells us in so many words that unions tend to lower wages. If such is the case, why do the employers of labor and their retainers oppose the unions?

Again, he writes, "Let us have an examining board which cannot be bought, to see how much a so called engineer knows. Determine whether he is a two-dollar man or a four-dollar man, then classify him." There is one serious objection to that proposition, we cannot all be on the examining board.

Further, he writes, "Many so called engineers working for two dollars per day are not worth it." He makes no argument in support of his statement and I ask him what standard he uses in arriving at the worth of a man?

In conclusion, Mr. McGahey writes, "I am 'from Missouri' when it comes to a union for education; I must be shown."

In order to aid him, I submit the following: The ability, both mental and physical, of the engineer is bought and sold on the market in much the same way as is sugar or steel. The sugar trust and steel trust have been organized to control the prices of sugar and steel and have been very successful from the trust standpoint; therefore, I propose that workers, including engineers, firemen, oilers, helpers and all others engaged in the generation of power, organize into one compact body, trust if you please, that they may better control the price of their labor. They should have an effective educational system to raise their efficiency and a compact organization to secure the results due a higher efficiency. Also, an employment bureau, and an insurance department to care for sick and disabled members.

If the trust method works well for our employers, why not for the workers? I hope others also will try to show Mr. McGahey.

C. C. HARRIS.

Springfield, Mass.

In the September 13 issue I read with interest Mr. McGahey's excellent article on "Engineers' Wages." I think he is about right. To abolish the merit system means not only to equalize wages, but to stop progress, for no man will stay up nights studying engineering to qualify for a position at the top which will not net him a better salary than that received by those lower down.

Some men have risen to the position of chief and have held it for many years simply through influence. Many chiefs have with them men of merit as assistants without whom they could not hope to retain their places. Every year some of them are forced out of their places on account of not being able to run an uptodate engine or ice machine which had been recently installed. Such men are constantly complaining, through jealousy, of others. They can rely only on the "oldest-man" system to keep up in the line of promotion which is sure to lead them to the chopping block when it becomes necessary to rebuild the plant.

Steam engineering today is more of a profession than a trade, and the men most successful are the ones who are the best informed on all subjects relating thereto. For instance, the uptodate office building or factory plant requires an engineer who possesses a general knowledge of the various trades in order to determine whether or not the repair work, done under his supervision, is completed in the shortest possible time and in a workmanlike manner. He is not a master machinist, steamfitter, plumber, electrician or gasfitter, millwright or boilermaker, yet he must possess a general knowledge of all of these trades. The license examination touches on all of them in so far as he is supposed to deal with them.

Trade unions are continually encroaching on the rights of the engineer's license, hoping thereby to make their own business good. The plumbers endeavored to pass laws prohibiting an engineer from putting in washers in sink hydrants and drain pipes. The steamfitters have tried to prohibit them from doing any piping. The elevator repairmen's union has endeavored to pass laws to stop the engineers from doing such work as putting new leathers into valves and packing plungers, thereby forcing the employers to dispense with the use of the machine and pay these men for the minimum of an hour to travel from the shop and a like period of time to travel back, simply to do a job which may require but a half hour.

The question may be asked, what are the engineer's duties? Does he not have all of the various kinds of work just mentioned to look after in the large building and factory plants? And is he not paid in accordance with the size of the plant and his ability to maintain constant service? The man in charge of a 350-horsepower plant cannot expect the same salary as the chief of a 20,000- to 50,000-horsepower public-service plant and no union could ever force the owner to pay him as much. The union might perhaps succeed in forcing the owner of the small plant to buy his power from the public-service company and thus dispense with the services of the engineer in his plant.

I read in a daily paper of the intention of the boilermakers' union to use their influence in securing a law compelling boilermakers on repair work to be licensed, on the grounds that engineers and firemen, machinists and other "inexperienced" men were constantly engaged to put in thimbles, tubes and to calk seams and rivets, and that work done by such men was frequently unsatisfactory and unsafe.

R. A. CULTRA.

Boston, Mass.

One or Two Boilers

In POWER for September 13, O. Lindblade asks for opinions as to whether it is better to use one or two boilers for a given service. I will not give an opinion but will state my experience and let him draw his own conclusions.

In a certain plant, two boilers were in use and between them they used 6800 pounds of coal per day. In order to do some work on one of them the load was carried with the other and the coal consumption fell about 1600 to 1800 pounds per day.

R. MCLAREN.

Berlin, Ont.

Horsepower on Nine Pounds of Steam

The development of an ultra high-speed, high-pressure and high-expansion engine was Charles T. Porter's latest engineering activity. An attempt is now being made to bring his work to the surface.

The recent death of Charles T. Porter recalls the fact that his latest engineering activity was directed to the development of an engine which should produce a horsepower on nine pounds of steam per hour. The essential features were 300 pounds initial pressure; superheat to a degree required to prevent initial condensation and furnish the heat converted into work in the first cylinder; jacketing with steam at the boiler pressure but not superheated, on account of the more active interchange between saturated steam and the containing surface; 30 expansions in a quadruple-expansion engine kept within reasonable dimensions by reason of the high mean effective pressure and a piston speed of 1250 or 1500 feet per minute; and fixed cutoff at the point of maximum efficiency. This engine was first made known to the public in a discussion by Mr. Porter of Dr. R. H. Thurston's paper upon "The Steam Engine at the End of the Nineteenth Century," presented to the American Society of Mechanical Engineers and to be found in Volume XXI of the transactions of that body, although some of its elements were described in a number of papers presented by Mr. Porter to the same society in 1894 and to be found in Volume XVI of its transactions. In still another paper in 1893 upon "The Limitation of Engine Speed," Mr. Porter, whose every utterance upon the high-speed engine, of which he was the father, has special significance, had recommended that 600 feet per minute be taken as the limit of piston speed; but this same paper demonstrates that speed is not limited by centrifugal stress in the flywheel, nor a tendency to knock on centers, nor vibration, but simply by the fact that an engine ought not to be run as fast as it can be run, and principally by the prejudicial effect of the large clearance required by engines of high speed. His new cam-operated valve, permitting him to give port openings sufficient to fill and clear a cylinder in the short time available at high speed without large clearance space, removed the main objection, and allowed him consistently to double his limitation in his own practice.

We understand that an engine embodying the ideas of Mr. Porter was built and tested by Prof. J. E. Denton, of Stevens Institute of Technology, with results so satisfactory that the Charles T. Porter Steam Engine Company was organized for its development and manufacture under the patents which Mr. Porter had taken out. The advent of the steam turbine, however, which was at that time being exploited with great energy by large financial interests, led Mr. Porter to advise the cessation of efforts to develop his project then, and he laid it away and, owing to his advanced age, never took it up again.

Looking through his engineering papers his sons have brought the matter again to the surface, and they, thinking that possibly the time is ripe, since the turbine has found its special field, for a revival of the steam engine for its legitimate sphere, have placed the papers in the hands of H. F. J. Porter, consulting engineer, of New York, who, with George H. Barrus, M. E., of Boston, was associated with Mr. Porter in the development of his ideal engine. Mr. Porter has renewed Mr. Barrus' association in the matter and has secured the active interest and assistance of Admiral Melville, now consulting engineer, of Philadelphia, to whom Charles T. Porter outlined his plans when the former was chief engineer in the navy. It is hoped that some way may be found of making available the work which the master devoted to the subject for so many years.

Coal Briquetting in the Year 1909

Due to the large supply of cheap fuel and the high cost of labor the briquetting industry in this country has not thrived. Last year, however, the briquetted output was more than 50 per cent. greater than in 1908.

According to Edward W. Parker, in the forthcoming volume on the "Mineral Resources of the United States," for the calendar year of 1909, issued by the United States Geological Survey, there was a marked increase in the production of manufactured or briquetted fuel in the United States in 1909, compared with the previous year.

"The quantity of compressed or briquetted fuel made in the United States in 1909 amounted to 139,661 short tons, valued at the works at $452,697. This was an increase over 1908 of 49,303 short tons, or 54.56 per cent. in quantity and of $129,640 or 40.13 per cent. in value. When this domestic output of briquets, however, is compared with the 17,000,000 or 18,000,000 tons manufactured in Germany, it appears insignificant; but it does show that the industry after many years of trial and discouragement is getting started.

"The successful operation of a briquetting plant must depend upon its ability to utilize one or more of several classes of low-grade fuel and to produce an article which will compete in efficiency and price with raw or unmanufactured coal or with coke. When comparisons are drawn between the extensive development of the briquetting industry in Europe and the small beginning in this country, it must be remembered that in foreign countries the raw fuel is relatively high priced. In Germany, where the briquetting industry has been most highly developed, the raw fuel is not only more expensive, but also of lower grade than that of the United States. Labor is less expensive in European countries, and, moreover, the wasteful type of coke oven known as the "bee-hive" is now practically unknown. Coal is coked in retort ovens, and nearly all of these are supplied with byproduct recovery equipment, which makes available a large supply of coal-tar pitch for binding material. These conditions are all favorable to the successful operation of briquetting plants.

"In the United States the industry is held back (1) by the large supply of cheap fuel, (2) by the higher cost of labor, which necessitates a higher price for the manufactured fuel, (3) by attempts, which have not yet ceased, to exploit secret processes for which extraordinary claims are made but which have not proved successful in commercial operation. If the byproduct recovery coke process had made more advances in the United States there would doubtless be available for binders a large supply of coal-tar pitch at prices which would induce the investment of more capital in the manufacture of briquetted fuel. There is an abundant supply of raw material which can be used for briquets, and in the utilization of which one of the greatest steps in the practical application of conservation principles could be made.

This consists of materials which unless used in this way are wasted. The classes of low-grade fuel available for this purpose are: (1) anthracite culm; (2) slack coal from semi-anthracite, bituminous and subbituminous-coal mines, which does not possess fusing or coking qualities, and is therefore not available for the manufacture of coke; (3) lignite, which disintegrates on exposure to air, will not stand transportation to distant points, and cannot be stored for any length of time; (4) coke breeze, which possesses high fuel efficiency, but which, because of its small size, cannot be used as such either for domestic or other fuel; and (5) peat, which usually occurs at long distances from the coal supplies, and which, if properly prepared, makes an excellent fuel. The utilization of slack from bituminous coal which possesses coking qualities does not enter into the problem, as it can be and is used for making coke and can be used satisfactorily under boilers. A large quantity of powdered fuel is consumed each year in the manufacture of cement, for which even the lowest-grade fuels can be satisfactorily used. This consumption is growing rapidly, with the phenomenal advance in the manufacture and use of cement and concrete, but it is not enough to take care of the enormous quantities of slack produced in the noncoking-coal regions, which is in many cases burned to keep it from 'cumbering the ground.'

"The utilization of coke breeze for briquetting purposes presents a problem distinctly its own; that is, the destructive abrasive effect which it has on the crushing apparatus and bearings of the machinery. It has been truly said that this material 'cuts like the diamond,' and the repair and replacement of parts of the machinery makes an expensive item in the attempts which have been made to use coke breeze in the manufacture of briquets. Two of the briquetting plants built in the United States have been for the purpose, primarily, of utilizing coke breeze. It is the custom to mix the breeze with some bituminous slack or anthracite culm, and it is found that such a mixture makes a more satisfactory briquet. The quantity of this coke breeze produced in the United States each year and practically wasted at the present time is from 2,000,000 to 3,000,000 tons."

In Mr. Parker's opinion:

"There is absolutely no reason for secrecy with regard to the constituents of patented binders. The field to be developed is so large that there is room for everyone, provided the expense is not inhibitive and the resultant briquet is a satisfactory fuel. The better educated the public becomes in the use of briquetted fuel the more rapidly will the industry develop, the most pronounced retarding element being the tendency to exploit secret methods of questionable merit instead of progressing along conservative lines in paths laid out by the experience of European countries.

"The production of briquets in the United States during the last three years has been as follows:

Year.	Quantity.	Value.
1907	66,524	$258,426
1908	90,358	323,057
1909	139,661	452,697
Total	296,543	$1,034,180

"In order to meet with popular favor in this country briquets must be of a convenient shape for shoveling and for the circulation of air in the firebox. They must be of suitable sizes for the purposes they are intended to serve, and must possess sufficient cohesion to resist fracture and abrasion under rough handling. The very large briquets made in European countries, particularly in Germany, the chief reason for which is the advantage for stowage in bunkers of steamships and tenders of locomotives, are not adapted for use in this country. They must be handled and stowed by hand, and must be broken up before being shoveled into the fire. Labor conditions in this country make the cost of such handling prohibitive.

Binders

"Experience in European countries and the investigations which have been carried on in the fuel-testing plant of the United States Geological Survey have demonstrated clearly that the successful briquetting of lignite may be accomplished without the use of any additional binding material, and that for the anthracite, semi-anthracite, bituminous and subbituminous coals the most satisfactory binders are coal-tar pitch, gas-tar pitch and asphaltic pitch, or inexpensive mixtures of which one or more of these are the principal constituents. The plants in successful operation in this country at the present time have added their experience to the evidence on this point. One plant began operating in 1910, using a binder of which oil obtained from the distillation of wood is one of the constituents, with apparently satisfactory results. Inorganic binders, though efficient in cementing quality, have the serious objection of adding to the ash but of adding nothing to the combustible character of the fuel. Pitch binders, on the other hand, contribute combustible material and do not increase the ash.

"Considerable attention has been given recently in Europe to the possibilities of sulphite pitch as a binder in the manufacture of briquets."

Separating Water from Steam

By Prof. C. H. Peabody

Though the distinction is not always made, it is convenient to consider that a boiler may prime or it may foam. When working under normal conditions the steam from a boiler will contain about one and one-half per cent. of priming or moisture; under somewhat unfavorable conditions the priming may be double that amount. This, then, may be called the normal condition of a boiler with proper steam space and free water surface.

When a boiler in regular working, in consequence either of condition of water supply or of peculiarities of construction, is liable to foam, the remedy is to put in a separator. Almost any good separator will do, and usually some stock pattern offered for sale on the market will be chosen because it can be easily obtained and will be cheaper than one made to order, even if made at home.

There are two things to be looked after in a separator; there should be a good chance for the steam to drop the water and no chance for it to pick it up again. To illustrate by aid of a certain separator designed at home and made by the neighboring boilermaker, a horizontal steam drum was made 3 feet in diameter and 6 feet long. Steam entered near the top at one end with an interior extension 2 feet long; the exit was at the top over this extension. Here the water simply fell to the bottom and the escaping steam had no chance to get hold of it again.

In their design most separators depend on the fact that water is heavier than steam and when moving at the same velocity has a much greater momentum. When the steam is given a whirling motion the greater inertia of the water carries it to the outside while the steam remains in the center. A sudden change in the direction of flow by means of baffle plates will also separate the water from the steam. Either method calls for a separator carefully designed to avoid producing a spray which may be easily picked up again by the steam.

A good separator will extract almost all the water from the steam, leaving about one per cent. of priming. This is the normal condition of so called dry steam from a boiler, and consequently the separator may always be considered as a remedy, as aforesaid. The only exception is found in the separator of certain water-tube boilers which have little or no steam space and instead have a separator. It is to be noted that such boilers are habitually run at fifty to a hundred pounds higher pressure than is found in the engine cylinder and consequently loss of pressure in the separator is of no importance.

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Power and The Engineer

Editorial

A Fig for Human Life

Three men were killed recently in Philadelphia by the explosion of a large cast-iron cylinder which was being tested with compressed air under high pressure. In the newspaper account of the affair the closing paragraph which is suggestive reads:

"The night superintendent, who could give no cause for the explosion, said that he had never before known of the explosion of a similar piece of apparatus. The casting is nearly two inches thick, he said, and could not have burst under the pressure put upon it unless defective. It had been inspected and was supposed to be sound."

Superintendents and others who should be held responsible in such exhibitions of the lack of mechanical common sense are always at a loss to account for the cause of anything which is due either to their carelessness or indifference. If a boiler explodes from overpressure, the failure is gravely charged to waterhammer, to some mysterious cause or to something done by one of the attendants who was providentially killed, and thus incapacitated for refuting the libel. Boilers, receivers and pressure tanks fail from overpressure and in a large percentage of cases the failures would not have occurred if there had been periodic intelligent inspection.

Boilers are provided with safety valves which the careful fireman blows every day or by other means ascertains that they are in working order. Steam-engine receivers are also provided with safety valves which are seldom or never tested. Both boilers and receivers fail and from the same cause, overpressure. But how seldom is the condition which makes overpressure possible investigated otherwise than in a farcical manner or for whitewash purposes.

The cast-iron cylinder which exploded in Philadelphia was evidently defective for it had been repaired and it was being tested with compressed air. Presumably the air pressure was applied for the purpose of finding leaks or other defects. If defective, air under pressure was certain to cause a destructive explosion and should not have been used. Air was used and what might logically be expected happened, notwithstanding the fact that the superintendent had never heard of any one of the hundreds of similar cases which are matters of history.

Had water been used, it would have shown the defects, if any, as readily as air, and if rupture occurred, the damage would have been confined to the cylinder alone, for water, having no elasticity, loses its pressure immediately on the occurrence of a rupture. With steam or air the case is entirely different and when a crack starts the whole expansive energy of the confined medium is expended in producing what usually proves to be a disastrous explosion. Applying the pressure test to any closed receptacle with air or any other elastic medium is a practice that cannot be too strongly condemned.

This cylinder "had been inspected and was supposed to be sound." How easily these all-excusing words, whether true or otherwise, are uttered, as though a supposition of safety on someone's part excused such utter disregard of the rights of the worker to be provided with reasonably safe working conditions. As report after report of disastrous accidents is received, and as the death roll is stretched by each additional victim of mismanagement or carelessness, the belief that human life is the cheapest thing on earth grows more widespread every day.

Water Hammer

It is an awful moment to the man in charge of a steam plant when mains begin to shake and bang as though a giant were pounding them, when each succeeding concussion seems more prodigious than the last, when it appears as though the snapping, swaying system must certainly let go at the next impact, and he has no idea whether the opening or shutting of this or that valve will stop the disturbance or incite to greater riot.

Water hammer is one of the most mysterious and unmanageable occurrences about a steam plant. It will start in an ordinarily well behaved system without apparent reason, and the attendant, ignorant of the cause, often can only await helplessly for it to play itself out, fortunate if in the combat between force and material the metal is the victor; killed or mained and discredited if it is not.

But there is no effect without a cause and engineering needs more practical knowledge of the causes and methods of water hammer. A slug of water traveling along a pipe has all the energy in it

(friction neglected) which has been expended in getting it into motion. Suppose for easy figuring, a pipe to have a cross-section of ten square inches. A plug of water which would fill a foot of it would weigh something over four pounds. Suppose the pressure on one end of this plug to be twenty pounds greater than it is on the other. The unbalanced pressure on the ten square inches of one end will be two hundred pounds and if that pressure pushes the plug one hundred feet it will expend twenty thousand foot-pounds of energy upon it, enough to get it into motion at a velocity of nearly five hundred and fifty feet per second.

This energy is a compound quantity comprising space and force—foot-pounds. To get the supposed plug of water into motion, a force of two hundred pounds has been exerted through one hundred feet. To bring it to rest a force must be exerted upon it so great that the product of that force and the distance through which it acts under the impact or in resisting the impact will amount to twenty thousand.

Suppose that the dead end or the valve or elbow upon which the plug impacts can move one-tenth of a foot, considerably over an inch; the average force opposed by the impacted surface to bring the plug to rest would be two hundred thousand pounds.

Is it any wonder that when forces and energies like these are allowed to manifest themselves pipes writhe, fittings break and heavy machines skate on their foundations?

It is easy to say that the way to avoid it is not to get water into the pipes, but so long as the pipes are used to carry steam there will be water in them under some conditions. All that one can do is to get it out as soon as possible, keep it out as constantly as possible and not let it form plugs, between the opposite ends of which there may be a difference in pressure which will get them into motion with harmful velocity. All pipes should be pitched in the direction of the normal steam flow and properly drained. Pockets and loops are dangerous. Care should be taken when connecting anything into the system not to reverse the direction of flow, perhaps pulling back flowing or standing water into a plug, nor to admit steam into a cold system in such a way that it can form plugs to be driven by the pressure behind them into the vacuum which the cold produces in front. When a system of piping has the water-hammer habit go at it intelligently to find out how plugs of water can form between the source of pressure and the place where the hammering occurs, and then fix it or run it so that they cannot form.

There is much to be learned upon this subject, and we should welcome discussion especially with concrete examples. If any case has been mastered, tell how you did it; if not, give all the particulars and perhaps POWER readers will show you how to vanquish it.

Drawing Fires

About the first instruction a new man in the boiler room receives is on handling the fires. Among other things, he is told to put either wet ashes or green coal on the fire in case of low water, a badly leaking pipe or burst tube. In other instances, he is told to pull the live coals from the grate should the blowoff pipe burst or any other accident occur that would lower the water to a dangerous level.

Such accidents frequently happen, so that pulling a fire is no uncommon occurrence, and easily accomplished when the grates are on a level with the fire door or they are of the dumping type. Pulling a hot fire from the sloping grates of some types of mechanical stoker in which the hottest bed of live coals is a foot or more below the furnace doors presents a more difficult problem. With such a stoker it would be almost an impossibility to draw the fires quickly, and should it become necessary, there would be no time to stop and think out a scheme for doing the work.

One engineer recently admitted that if such a demand should arise, he would not know what to do. He had considered the matter, but had not settled on any particular method of procedure.

How many more are in the same position, not only in regard to drawing a fire, but in the matter of handling other power-plant apparatus in case of emergency? Such matters should be firmly settled in mind in advance of the emergency call. Every engineer and fireman should have a clear idea as to what to do in case it becomes necessary to protect a boiler from the heat of the furnace. Would it be better to draw a fire or cover it with green coal or wet ashes? In the case of a furnace where the fuel bed is considerably below the furnace door, or where there are no fire doors in the boiler front, there is but small chance of drawing a fire, and it is a question as to whether it is even advisable to do so.

Blanketing a fire is the quickest way of reducing the furnace temperature when there is a pile of coal in front of the furnace. But what would be the better way if the boilers were equipped with dutch-oven furnaces in which the stokers are fed from the top of the setting and there is no coal on the fire-room floor? What would be the best thing to do in case the ashpits were so arranged that the ashes fell to the basement out of reach of the men in the fire room?

These conditions may not exist in all steam plants, but they do in one instance. The furnaces are of the dutch-oven type, the grates are inclined toward both sides of the furnace, and the coal is delivered from overhead coal bunkers. Most of the incandescent fuel in the furnace is some distance below the furnace door and the ashes fall into an ashpit in the basement. There is no coal on the boiler-room floor, and the ashes are not within reach.

What should be done if it became necessary to reduce the furnace temperature instantly in case of serious accident to any of the boiler fittings?

Corn Cobs as Fuel for Steam Boilers

A Western correspondent wants to know if corn cobs mixed with slack coal and used as fuel are in any way injurious to a boiler. He is engineer of a roller mill where the cobs are given away, and when he proposed to burn them the objection was made, and generally sustained, that they would ruin the boiler. He tried them, however, mixing them with from 20 to 25 per cent. of slack coal, with the result that the coal burned better, he did not have to use a slice bar, got along with less draft and the fireman after a day or two's experience with them was much pleased as it made his work easier.

We do not see why there should be any injurious results from the use of this kind of fuel. It is pure cellulose, the same as soft wood, and contains nothing that would make the products of combustion deleterious to the boiler. If there is any general conviction, however, on the part of people who live in sections where cobs abound that their use for fuel in steam boilers is not advisable, there is likely to be some basis for it and we should be glad to have some information founded upon actual experience. There must be thousands of tons of this material produced every year and with the exception of forming the basis of the Missouri meerschaum, we know of no other application for them.

Do you know all that you ought to know about the proposed Institute of Operating Engineers? Inquiries addressed to the Institute of Operating Engineers, 29 West Thirty-ninth street, New York City, will secure full particulars concerning the purpose of this organization and reasons why it will pay you to become a member. It may pay you to look this matter up, right now.

Zinc is often used to prevent the corrosion of boilers. Its efficiency is due to the fact that any metal with a greater tendency than iron to dissolve, on which hydrogen is liberated with more difficulty than on iron, will protect the latter at the expense of the more soluble metal. The protection, however, becomes ineffective in pure water at a distance greater than an inch. Salt or some other electrolyte will extend the zone to 20 inches or more. will extend the zone to 20 inches or more.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Influence of Reverse Lever

With a link-motion valve gear, what effect does "hooking up" have on the steam distribution?

I. R. L.

"Hooking up" causes a valve travel which is a resultant of the motion of both eccentrics, and produces the effect of a single eccentric with a shorter throw and more angular advance hastening each event. Lead is increased, and cutoff and compression occur earlier in the stroke.

Pressure on Flat Surfaces

How is the allowable pressure on flat unstayed surfaces calculated?

P. F. S.

One rule says: Multiply the thickness of the plate in inches by ⅙ of its tensile strength, divide this product by the area in square inches and multiply the quotient by 0.09 for the working pressure.

Sun and Planet Cears

With two gear wheels of equal diameter, one stationary and the other revolving around it, how many turns on its axis will the revolving gear make in going once around the stationary one?

F. H. R.

The moving wheel will make two complete revolutions on its axis for each circuit.

Mean Effective Pressure Rule

What is the rule for finding the mean effective pressure in an engine cylinder when the steam pressure and point of cutoff are known?

E. P. R.

The mean pressure of steam expanding in an engine cylinder, neglecting condensation and clearance, is calculated by the formula,

$$Pm = p\,\frac{1 + hyp.\ log.\ R}{R}$$

in which

Pm = Mean pressure;
p = Initial pressure;
R = Ratio of expansion.

The mean effective pressure is the mean pressure minus the back pressure.

Specific Gravity

What is meant by the term specific gravity, and how is it found?

S. G.

It is the weight of a substance compared with the weight of an equal volume of water. The specific gravity of lead is 11.33, which means that a cubic inch of lead weighs 11.33 times as much as a cubic inch of water.

The specific gravity of a substance is found by weighing it first in the air and then in water and dividing the weight in the air by the difference between the weight in the water and in the air. For instance, a body weighs 4.25 pounds in the air and 2.5 pounds in water; its specific gravity is,

$$\frac{4.25}{4.25 - 2.5} = 2.428$$

Manometer

What is a manometer?

T. F. B.

Any instrument used for the purpose of measuring the pressure of elastic fluids. The term is usually applied to draft gages, mercury columns and similar apparatus, though it is equally applicable to steam gages and steam-engine indicators.

Benefit of Vacuum

How does a vacuum increase the power of an engine?

B. O. V.

When an engine is run noncondensing the expanded steam must be pushed out of the cylinder through the exhaust port against the pressure of the atmosphere, which is approximately 15 pounds per square inch. But when running condensing the steam is pushed out of the cylinder against the pressure in the condenser, which is below that of the atmosphere. The difference between the pressures on opposite sides of the piston is the measure of the work done by the engine. Removing a part of the resistance by exhausting into a condenser increases this difference in pressure and consequently the power of the engine.

Size of Engine Needed

Will a 20x42-inch Corliss engine, with 90 pounds of steam, running at 75 revolutions per minute, consume more coal to generate 100 horsepower than an 18x36-inch engine under the same conditions, and if so, how much? I have an 18x36-inch engine practically worn out and am considering replacing it with one 20x42-inch and desire to know whether there will be any difference in the coal consumption.

S. E. N.

Either engine at the speed and steam pressure mentioned would be much too large for a load of 100 horsepower. The larger engine will take more steam for the work than the smaller one and this more than one of the right proportions, but just how much can only be guessed at. An engine 14x42 inches with 90 pounds pressure, running 75 revolutions per minute, will develop 100 horsepower economically.

Release and Compression

What is the meaning of release and compression?

R. A. C.

Release refers to that point in the stroke at which the valve opens the exhaust port and releases the steam in the cylinder. Compression refers to that portion of the piston stroke which is accomplished between the closure of the exhaust port in front of the piston and the end of the stroke.

Horsepower of Boilers

I have two horizontal return-tubular boilers, 5x16 feet. What is their horsepower?

H. O. B.

A boiler should develop one horsepower for each ten square feet of heating surface. As the heating surface is not given, an approximation may be had by using the thumb rule

$$\frac{Diameter^2 \times length}{5} = horsepower$$

Substituting

$$\frac{5^2 \times 16}{5} = 80$$

the approximate horsepower of each boiler.

Receiver Pressure

What is the rule for finding the proper pressure to be carried in the receiver of a compound engine?

P. R. P.

There is no rule. For ordinary cylinder ratios of 3 and 4 to 1, operating condensing with a steam pressure of 100 to 125 pounds and a fair load, the receiver pressure should be between 4 and 10 pounds per square inch, and from 10 to 20 pounds for steam pressures from 150 to 175 pounds. The best results are usually obtained where the load is equally divided between the high- and low-pressure cylinders. That receiver pressure which will cause the governor to revolve in the highest possible plane for any given load is the right pressure.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

Lagonda Multiple Strainer

The Lagonda Manufacturing Company, Springfield, O., has recently perfected a multiple strainer for removing impurities in feed water, circulating water, etc. These strainers can be installed either outside or inside of the buildings and in any position, horizontal, vertical or inclined. They are made up of different sections which can be cleaned, one at a time, without interrupting the flow of water.

The strainer consists of a cast-iron body having several removable strainer baskets, the number depending upon the size of the line. These baskets can be removed for cleaning, without shutting down the pumps, and as the mesh is made very fine, they eliminate a large per cent. of foreign matter contained in the water.

Referring to Figs. 1 and 2, it will be seen that after the water enters the inlet pipe, it passes up to the top of the valve chamber, where it divides, going down through all of the baskets in multiple. When it is desired to clean the strainer, one of the baskets is drawn to the upper part of the chamber by turning the hand-

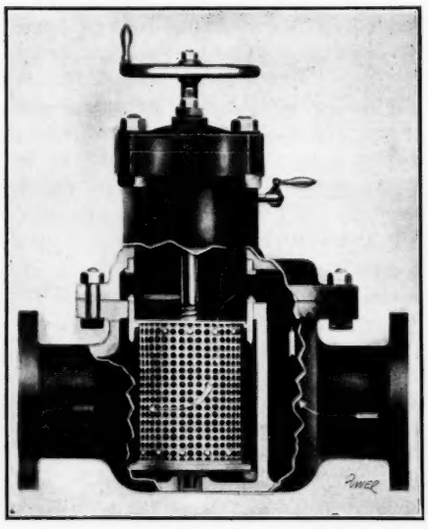


FIG. 1. SIDE VIEW OF MULTIPLE STRAINER

wheel; at the same time the valve collar is forced tightly against the valve seat and the valve disk on the bottom of the basket seats on the valve collar. This is all done automatically and entirely shuts off the water supply from the section containing the basket to be cleaned. By means of a small bypass the pressure in this chamber is relieved and the bolts at the top loosened and the flange cap tilted over, exposing the basket.

The basket may then be taken out and cleaned. In replacing the basket the operations are exactly the reverse. The next basket can be removed in the same way and the whole strainer cleaned without shutting off the water. Should an obstruction rest upon the top valve collar, the basket, when raised to a cleaning position, will have a tendency to tilt the obstruction either into the basket or out of the way of the valve. This is due to the fact that the basket travels nearly its entire distance before the lower valve disk comes into contact with the lower seat of the valve collar.

The effective straining area of the strainer is from two and one-quarter to four times the area of the pipe line and in removing one basket for cleaning the straining area is not reduced more than 30 per cent., it is claimed; thus the pipe line is never throttled in the process of cleaning.

All of the internal parts subject to the

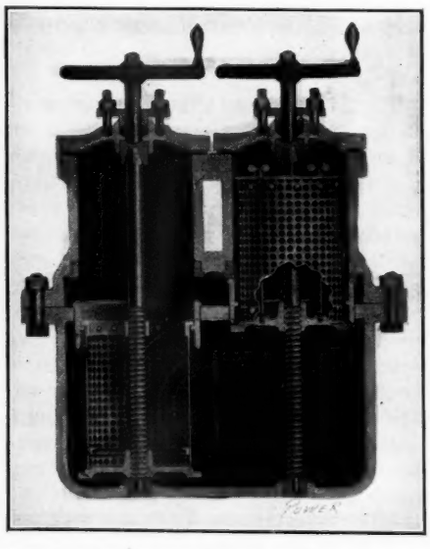


FIG. 2. SECTIONAL VIEW OF TWO-BASKET STRAINER

action of water are made of bronze, thus eliminating all troubles from corrosion. No leather or rubber washers are used. These strainers are built in sizes from 2 to 48 inches, having two to six baskets, the number depending upon the size of the strainer. They are also suitable for use in either suction or pressure lines and are built to stand working pressures up to 200 pounds per square inch.

In practice, one of the baskets is left out of service so that in case the baskets in use should become clogged the clean basket can be quickly lowered into service.

Weber Coniform Reinforced Concrete Chimney

Details of the new coniform type of chimney now being built by the Weber Chimney Company, of Chicago, Ill., are illustrated in Fig. 1. This chimney is so named for the reason that it is built in the form of a true frustum of a cone, and having a uniform thickness of walls at any given cross-section through-

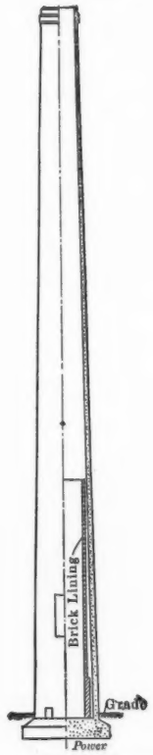


FIG. 1. DETAILS OF WEBER CONIFORM CHIMNEY

out. The walls and the diameter of the chimney decrease in a uniform ratio from the base of the chimney to the top. Where conditions require, the structure is lined with a suitable brick or reinforced-concrete lining to whatever hight may be necessary, but usually about one-third the total hight.

The reinforcement of this type of chimney consists of vertical bars encircled at regular intervals by steel rings properly bent to the desired circle. The weight and number of these bars are dependent upon the dimensions of the chimney.

Steel bars in lengths of from 16 to 30 feet are used, the joints being made irregular, preventing so far as possible many joints at one hight. In the design of the chimney all the bending forces caused by wind pressure, etc., are taken up by the vertical steel reinforcement, and the resistance of the concrete itself against tension is not considered in the calculations.

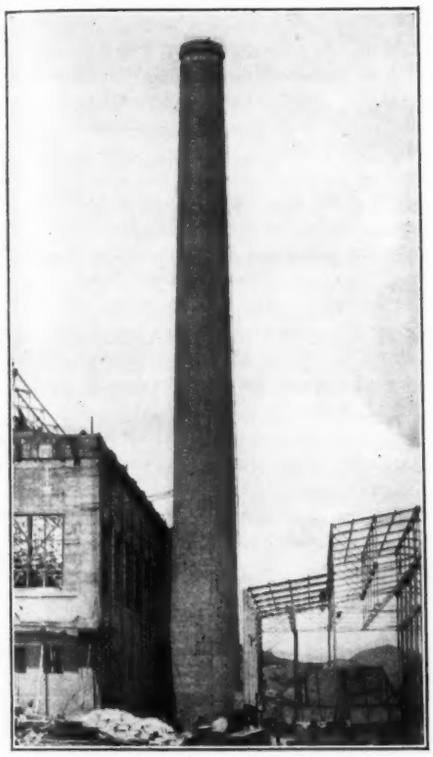


FIG. 2. CHIMNEY BUILT FOR MIAMI COPPER COMPANY

In constructing the coniform type of chimney a special form consisting of a series of wooden units is employed. These wooden units are held together in a rigid manner, forming a circle, at the same time retaining the principle of flexibility, so that the necessary units can be removed from the form at regular intervals in order to properly reduce the diameter of the chimney and the thickness of the walls in uniform ratio as the hight increases.

Fig. 2 gives a view of a finished chimney and is a good example of the new type of stack. The chimney and foundation constitute one single solid piece, the reinforcing steel bars from the chimney shaft going down into and being embedded beneath the steel bars in the foundation. The latter, which is thoroughly reinforced, is 27 feet 6 inches square and its greatest thickness is 6 feet 3 inches.

The hight of the chimney is 200 feet and it is 12 feet in inside diameter at the top; the largest outside diameter at the base of the shaft is 20 feet 4 inches, gradually tapering to the top where the outside diameter is 12 feet 10 inches, the thickness of the wall at the top of the chimney being 10 inches. This chimney has a firebrick lining to a hight of 68 feet above the ground level.

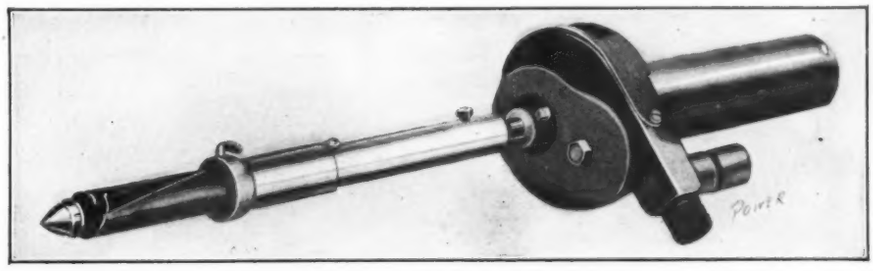
Stirling Packing Tool

This tool is an automatic machine for inserting and packing the lacings or strings in the stuffing boxes for the tube ends of surface condensers. It places and starts the end of the lace at the bottom of the stuffing box and automatically winds the lacing about the tube and hammers in each coil; all at the one operation. Each coil of lace is perfectly flattened and wound tightly against the tube, thus keeping it out of the threads of the ferrule.

The number of boxes that can be packed within a given time is variable, depending upon the condition of the tubes and stuffing boxes, the position of the work and the ability of the operator. For ordinary work, the manufacturer claims that six to nine boxes a minute throughout the day is the average. Approximately 3000 may be packed in a day.

All sizes of boxes can be packed with one machine, the hammer tubes being interchangeable and fitting 5/8-inch and 3/4-inch stuffing boxes; other sizes may be obtained.

The machine is operated with compressed air. When through packing with the air tool, the hammer can be pushed back and a pin inserted to hold it in place. The ferrule attachment can then be put on after taking off the packing tool. This attachment enables the ferrule to be run on tight in a second. This tool can be detached and used with an auger brace or breast drill.



STIRLING PACKING TOOL

The machine has already been placed in the navy yards of Boston, Brooklyn and Philadelphia, and from all accounts is giving the best of satisfaction. It is manufactured by Robert R. Stirling, 847 Avenue C, Bayonne, N. J.

Dean Dumping Grate

The use of the Dean dumping grate described and illustrated herewith, enables the fireman to thoroughly and

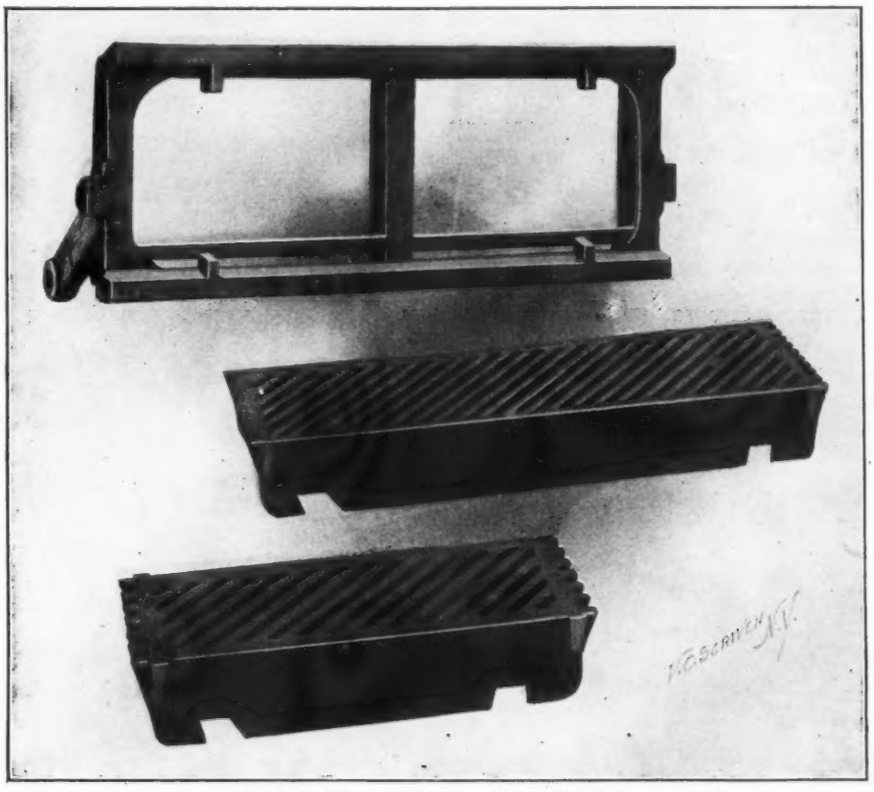


FIG. 1. GRATE SECTIONS AND CRADLE

quickly clean his fire and maintain steam pressure during the cleaning period, which varies from two to seven minutes per boiler according to the size of the grate surface.

The grate sections are each held in a cradle, as shown in Fig. 1. The cradle is designed to give two points of support for the bar. The bar is held in position on the cradle by an angular slot in the rear end, which engages a corresponding rib on the cradle. There is no tendency of the dumping bars to warp downward and break in the middle, it is claimed.

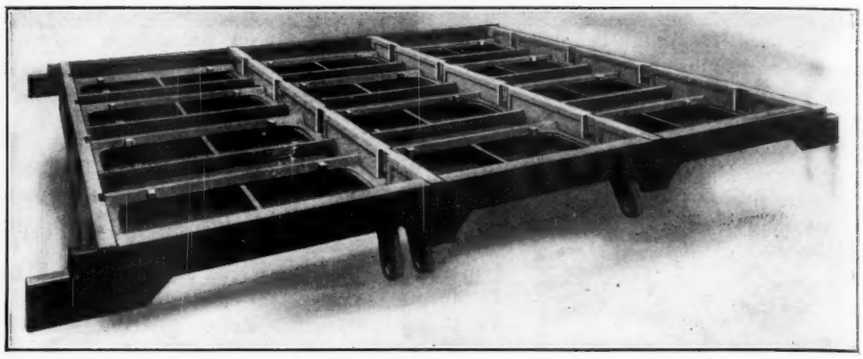


FIG. 2. GRATE FRAME AND CRADLES

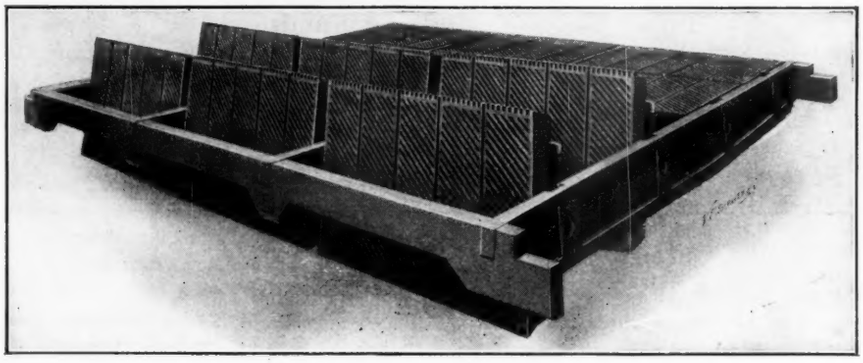


FIG. 3. POSITION OF BARS WHEN TIPPED

The grate frame and the cradles on which the bars rest are shown in Fig. 2. Beveled slots are provided in the side and center frame castings, the functions of which are to admit the journals of the cradles. By this method of construction an open slot is avoided, the original strength of the casting is maintained and the use of caps and tap bolts avoided.

Fig. 3 shows the position of the bars when tipped. To clean the front half of the grate, the live coals are pushed onto the rear bars, when by tipping the cradle to an angle of 65 degrees the grate is freed of all ash and clinkers.

The bars are then returned to normal position, and the live coals raked forward onto the two front sections, when the two rear bars are dumped free from ashes and clinker. The entire grate is thus cleaned thoroughly in a very few moments.

In Fig. 4 is shown a twelve-cradle grate designed for a furnace 10 feet 4 inches wide by 7 feet deep, with the bars in a normal position. It is claimed that with this size of furnace the individual grate bar remains perfectly flat owing to the principle of support embodied in the cradle.

The method of installation as applied

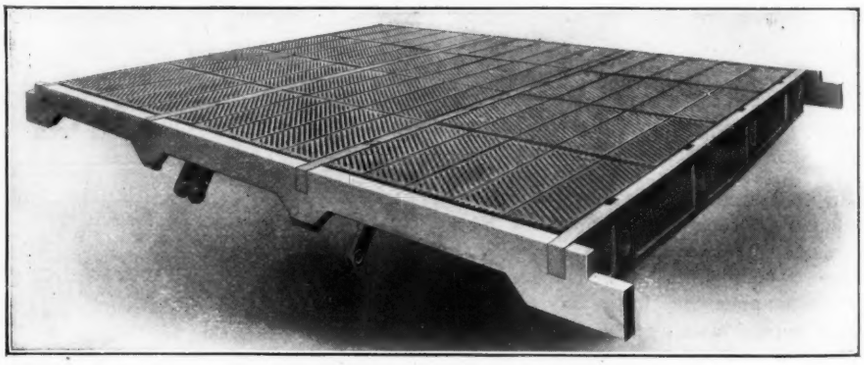


FIG. 4. A TWELVE-CRADLE GRATE

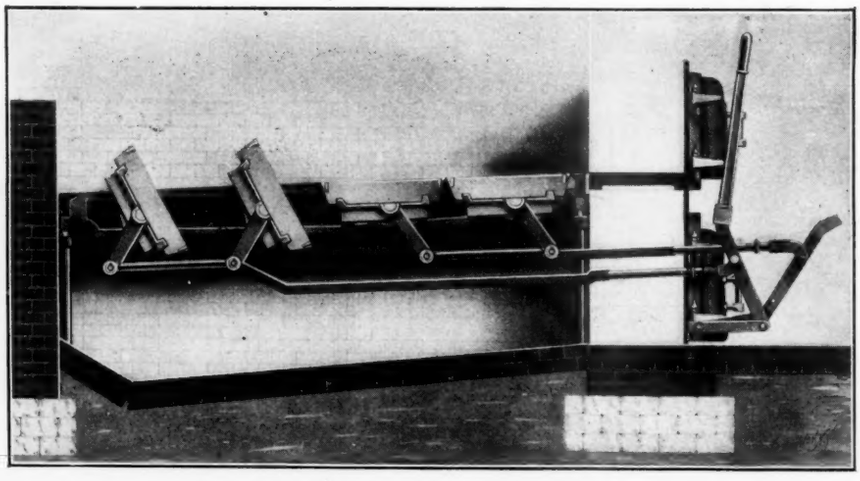


FIG. 5. FURNACE INSTALLED IN BRICK SETTING

to brick-set furnaces is shown in Fig. 5. The cradles tip in tandem, two front and two rear, which greatly increases the clearance between the floor line and the bars when the grates are tipped. This clearance is necessary to permit the ash to drop clear. This design also permits the rods to be brought out so as not to come in contact with the ash, and is specially advantageous on installations having shallow ashpits. The space required for the operating levers is evident in Fig. 5.

All operating rods are made of flat steel. The handles are made of malleable iron and the levers and links of forged steel. This grate is made by Washburn and Granger, 50 Church street, New York City.

Stumpf's Engine Turbine Combination

In reciprocating steam engines where the steam is expanded up to the end of the piston stroke, it is impossible to carry out the expansion to the limit. Thus there is always a rounded toe on the diagram showing a loss, as indicated by the section lines in the diagram, Fig. 1. To render this lost energy, or a considerable portion of it, available for use without impairing the efficiency of the engine, Prof. Johann Stumpf, in a patent recently described in *The Mechanical Engineer*, proposes to combine a unidirectional-flow steam engine with a suitable turbine in such a manner that the turbine is operated by the exhaust steam from the engine. When the piston uncovers the exhaust ports in the cylinder wall near the end of its stroke, the expanded steam in the cylinder passes through the exhaust ports, and thence into a low-pressure or exhaust-steam turbine, where the energy of the steam is extracted. In such a plant the piston-controlled exhaust ports offer a very considerable area of passage for taking off the expanded steam from the cylinder, and further, they enable the application of simple means for combining a turbine with a steam engine. Such a combination is known in the case of ordinary reciprocating steam engines with valve-controlled exhaust. It has also been proposed to lead the exhaust fluid from an internal-combustion engine directly from a single exhaust opening into a turbine.

Fig. 2 is a cross-sectional elevation through the center of the cylinder and the turbine casing of the arrangement, and Fig. 3 is a side elevation. Steam is admitted to the cylinder *A* of the unidirectional-flow steam engine through inlet valves *B*. The piston working in the cylinder *A* is adapted, in its travel, to control a plurality of exhaust ports *C* located in the walls of the cylinder and about the center thereof. Shortly before reaching its end position, namely, the dead point in the crank position, the piston uncovers the exhaust ports *C*, and the steam then passes through pipes *E*, which are directly connected to the exhaust ports *C* and lead to or themselves form the nozzles of a turbine *D*. A few of the blades on the rotor of the turbine are indicated in Fig. 2. Each port of the ring or row is shown as connected to a nozzle pipe *E*, which has its narrowest point at or in the immediate neighborhood of the cylinder wall. The long, narrow part of the nozzle pipe allows a gradual increase in the velocity of the steam, which may reach as high as 1300 to 1600 feet per minute. It will be seen that the turbine receives puffs of steam just at or about the dead point of the engine crank, and therefore the maximum is obtained in the turbine just at when the minimum turning moment is being applied by the engine.

The exhaust from the ports *C* may, if desired, be led into a receiver, consisting of an annular chamber arranged as a belt around the cylinder, and the receiver may be connected to the turbine. The exhaust steam from the engine cylinder may be mixed with steam at the pressure of the condenser, and this mixture, at the pressure corresponding to the proportions of the mixture, may then be led to the nozzles of a turbine, where the pressure rapidly falls. In all cases the full advantages of the condenser pressure are obtained, as shown by the diagram from the reciprocating engine, which is just the same as though no turbine were employed. A number of parallel rows of ports may be provided in the cylinder, and one or more of these rows connected to the turbine and the remaining row or rows to the condenser.

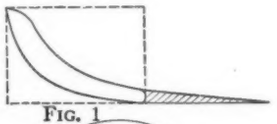


FIG. 1

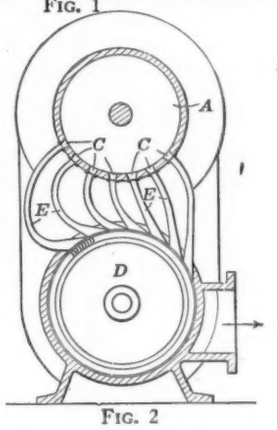


FIG. 2

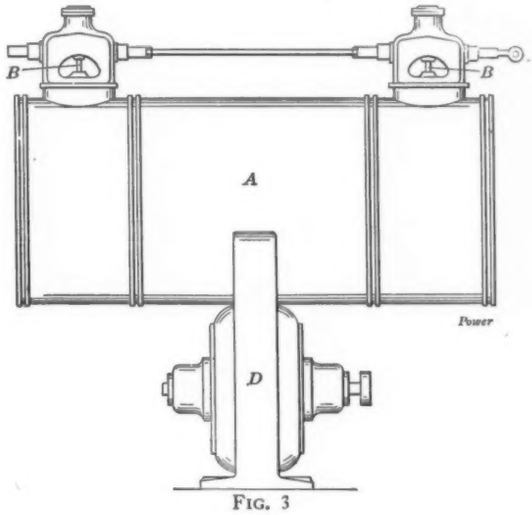


FIG. 3

A Practical Evening Course in Heating and Ventilating

The course has been especially provided by the Harlem branch of the Young Men's Christian Association, 3-15 West One Hundred and Twenty-fifth street, New York City, for engineers, draftsmen, mechanics and salesmen of heating appliances. It will consist of lectures, demonstrations of systems and appliances, discussions and the answering of pertinent questions.

During the first part of the year, gravity, steam and hot-water heating and ventilating apparatus for small buildings will be taken up. This will include the proper proportioning of boilers, mains, radiators, chimneys and flues. Also all special methods of steam and water circulation applicable to small buildings.

During the second part of the year the fan systems of heating and ventilating, and the heating and ventilating of office buildings, hotels, factories, etc., will be covered; this will include such parts of the power plant as are usually in the care of the heating engineer, and will cover mechanically circulated and thermostatically controlled steam and hot-water systems. Individual needs will be given special attention.

The fee for the complete course of two terms is $12; or $7 for half the course of one term. Membership in the Young Men's Christian Association is a preliminary requirement. Membership fee costs either $6 for limited privileges or $12 for full privileges, which include gymnasium, etc.

BOOK REVIEW

Bulletin 425, "The Explosibility of Coal Dust," issued by the United States Geological Survey, traces the growth of the belief in the explosibility of coal dust, summarizes the experiments and mine investigations that have established this belief, and gives the present status of preventive measures. It contains references to and descriptions of experiments made at the testing station of the United States Geological Survey, at Pittsburg, Penn. This station was established and equipped for the purpose of carrying on investigations relating to mine explosions, fuels and structural materials.

"Only within comparatively few years has the dry dust of bituminous and lignitic coals been generally recognized as an explosive agent more insidious, threatening and deadly to the miner than firedamp. Firedamp carries its own flag of warning—the 'cap' in the safety lamp—but coal dust, though visible, does not attract attention until present in large quantities. Firedamp is of local occurrence, and except in notable and very exceptional cases is controllable by careful manipulation of ventilating currents. If by mischance a body of firedamp is ignited in a mine, the force of the explosion is terrific, but the effect is localized unless dry coal dust is present, or

unless, as it very rarely happens, an explosible mixture of methane gas and air extends through large areas of the mine. In a dry mine, dust accumulates everywhere and the blast from the ignition and combustion of bituminous dust may traverse miles of rooms and entries and wreck structures at the entrance to the mine. The comparative potential destructiveness of gas and of bituminous dust is strikingly shown by the history of the Pennsylvania anthracite mines. These mines not infrequently have large inflows of gas and the resulting mixtures of gas and air have sometimes been ignited, yet no such wide-sweeping explosions have taken place, despite the presence of dry anthracite dust, as have happened in excellently ventilated bituminous mines."

BOOKS RECEIVED

RULES AND FORMULAE. Indorsed and adopted by the International Master Boilermakers' Association, New York. Cloth; 65 pages, 4x6 inches; 1 illustration. Price, $1.

SWINGLE'S PRACTICAL HANDBOOK FOR MILLWRIGHTS. By Calvin F. Swingle. Frederick J. Drake & Co., Chicago, Ill. Cloth; 411 pages, 5½x7¾ inches; 226 illustrations; indexed. Price. $2.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

FLUID MOTOR. Carlos F. Benitez, Guadalajara, Mexico. 971,517.

STEAM TURBINE. Johann Friedrich Max Patitz, Milwaukee, Wis., assignor to Allis-Chalmers Company, Milwaukee, Wis., a Corporation of New Jersey. 971,555.

ROTARY ENGINE. George T. Geer, Denver, Colo. 971,671.

REVERSIBLE TURBINE. Richard Cramp, East Ham, England, assignor to Cramp's Patent Reversible Turbine, Limited, London, England. 971,730.

ENGINE. Christopher John Lake (name changed from John Christopher Lake by judicial order), Bridgeport, Conn. 971,760.

INTERNAL COMBUSTION ENGINE. Theodor Reuter, Winterthur, Switzerland. 971,793.

MOTOR. Daniel F. Lawrence, Brandon, Vt. 971,854.

STEAM TURBINE. Thomas R. Morgan, Archibald L. Atwater and Benjamin A. Crowther, Pittston, and William M. Ash, Williamsport, Penn. 971,918.

GAS ENGINE. George R. Morris, Chicago, Ill. 971,919.

LIQUID FUEL INTERNAL COMBUSTION ENGINE. Leon Wygodsky, New York, N. Y. 971,954.

WATER MOTOR. Elijah R. McCreary, Bush, La. 972,010.

INTERNAL COMBUSTION ENGINE. David Roberts and Charles James, Grantham, England. 972,024.

EXPLOSIVE ENGINE. John H. Fitch, Ludington, Mich. 972,071.

BOILERS, FURNACES AND GAS PRODUCERS

FURNACE. William H. McGuire, Hobart, Okla. 971,548.

GRATE. Horace H. Ruggles, Boston, Mass. 971,565.

BOILER. Luther C. Rhea, Columbus, Ohio. 971,561.

STEAM GENERATOR WITH WATER IMMERSER FLAME. Oscar Heinrich Ulrich Brunler, Brussels, Belgium. 971,724.

OIL-BURNING FURNACE. Ludwig Koczwara, Prague-Kgl, Weinberge, Austria-Hungary. 971,902.

STEAM BOILER FURNACE. August H. Hausler, South Chicago, Ill. 971,996.

HYDROCARBON BURNER. George J. McPherson, Salt Lake City, Utah, assignor to International Oil Gas Producer Company, a Corporation of Utah. 972,014.

NATURAL GAS BURNER. Charles E. Bunner, Grafton, W. Va. 972,056.

POWER PLANT AUXILIARIES AND APPLIANCES

SUPERHEATER. William F. Buck, Chicago, Ill., and Henry W. Jacobs, Topeka, Kas. 971,522.

QUICK-OPENING VALVE. William L. Osborne, Chicago, Ill. 971,552.

FEED-WATER HEATER. William S. Ferguson, Leesville, La. 971,599.

CARBURETER. George M. Schebler, Indianapolis, Ind., assignor to Wheeler & Schebler, Indianapolis, Ind., a Copartnership. 971,689.

STEAM TRAP. Julius R. Tanner, Pittsburg, Penn., assignor to the Pittsburg Valve, Foundry and Construction Company, Pittsburg, Penn., a Corporation of Pennsylvania. 971,801.

NON-RETURN VALVE. Julius R. Tanner, Pittsburg, Penn., assignor to the Pittsburg Valve, Foundry and Construction Company, a Corporation of Pennsylvania. 971,802.

STEAM TRAP BOILER FEED AND WATER METER. George W. Cole, Buffalo, N. Y. 971,831.

CENTRIFUGAL PUMP. Ferdinand W. Krogh and Carl A. Krogh, San Francisco, Cal. 971,849.

CARBURETER. George M. Schebler, Indianapolis, Ind., assignor to Wheeler & Schebler, Indianapolis, Ind., a Copartnership. 971,862.

GREASE GUN. Samuel P. Townsend, Orange, N. J. 971,939.

PRESSURE-REDUCING VALVE. Thomas P. Ford, New York, N. Y. 971,982.

PIPE JOINT. Charles R. McKibben, Pittsburg, Penn. 972,119.

CROSSHEAD. Frederick H. Smith, Pittsburg, Kas., assignor of one-half to Clarence R. Widby, Pittsburg, Kas. 972,133.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC SWITCH. Walter S. Mayer, Philadelphia, Penn., assignor to the Machen & Mayer Electrical Manufacturing Company, Philadelphia, Penn., a Corporation of New Jersey. 971,623.

ELECTRICAL CONDENSER. William W. Dean, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio, a Corporation of Ohio. 971,667.

ELECTRIC-CURRENT GENERATOR. Herman A. Schmidt, Chicago, Ill. 971,690.

MAGNETIC SEPARATOR. Friedrich Oscar Schnelle, Frankfort-on-the-Main, Germany, assignor to Wetherill Separating Company, New York, N. Y., a Corporation of New Jersey. 971,692.

THERMO ELECTRIC COUPLE. Albert L. Marsh, Detroit, Mich., assignor to Hoskins Manufacturing Company, Detroit, Mich., a Corporation of Michigan. 971,767.

ELECTRIC IGNITION APPLIANCE. Archibald Montgomery Low, Brook Green, London, England. 971,908.

SPARK GAP FOR RADIOTONE WIRELESS TELEGRAPH SYSTEMS. Emil J. Simon, New York, N. Y., assignor to the Radio Telephone Company, New York, N. Y., a Corporation of New Jersey. 971,935.

METHOD OF AND APPARATUS FOR GENERATING ELECTRICITY. Botho Schwerin, Frankfort-on-the-Main, Germany. 972,029.

INDICATING SWITCH BUTTON. John A. York, Franklin, Conn. 972,048.

MAGNETIC ORE SEPARATOR. Anders Gustaf Holmberg, Langgrufvan, Sweden. 972,109.

ELECTRICAL HEATER. Milton H. Schoenberg and George T. Marsh, San Francisco, Cal., assignors to Appliance and Electric Device Company, a Corporation of California. 972,131.

INDUCTION MOTOR. John E. Webster, Pittsburg, Penn., assignor, by mesne assignments, to Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., a Corporation of Pennsylvania. 971,649.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore and treas., D. L. Gaskill, Greer